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NEW YORK, JUNE, 1892.

THE New York rapid transit project is now in the hands of a commission appointed by the Supreme Court, which is examining into the objections made by property-owners. Legal processes are slow; and no one expects the underground project to go through for a long time to come.

THE Baltimore Belt Railroad is to try electrical locomotives for moving trains through its tunnels, and the Thomson-Houston Company is to furnish the plant, including motors of 500 H.P. The Belt road is a connecting line, a large part of which is underground, and the work over its tracks will be chiefly yard and transfer work.

THE waters of the Mississippi have been unusually high this year, and serious apprehension has been felt all along the lower river. Several crevasses in the levees have occurred and much emergency work has been required to prevent others. The waters were not falling at latest accounts, and cannot be expected to for some time, since high water and floods are reported on the Upper Mississippi and Missouri and their tributaries, and more damage is feared.

THE new road law of New Jersey, as amended this year, authorizes the county boards to contract for the building of macadamized roads, under certain regulations. The State will contribute one-third of the cost, up to an amount not exceeding $75,000 yearly. The building of macadamized roads is not altogether optional, the county board being compelled to act on petition of two-thirds of the property-owners on any road. The law was advocated by a large number of farmers and other owners of property.

THE next report of the Irrigation Division of the Department of Agriculture will show that some 9,000,000 acres of land are now under irrigation, and that arrangements have been made to take up a large additional area as soon as water supplies are provided for. A tendency to monopolize large tracts is indicated.

A BILL admitting foreign-built steamships to American registry has passed the House of Representatives. The conditions are somewhat stringent; the steamers must be of at least 8,000 tons register and capable of making 20 knots an hour; 90 per cent. of their value must be owned in the United States and the owners must have contracted for the construction of other vessels of equal tonnage and speed in this country.

The terms of this bill apply at present only to the steamers *City of New York* and *City of Paris* of the Inman Line, and these steamers will hereafter sail under the American flag. It is stated that the Inman Company will have two large steamers built—probably at the Cramp yards in Philadelphia—to add to the line, which are expected to be the largest and fastest ships in the Transatlantic trade. Similar bills have been introduced to give American registry to some steamers for the China line of the Pacific Mail Company.

THE biennial meeting of the International Railroad Congress is to be held this year in St. Petersburg, and the Executive Committee announces that the first session will be held August 20 next. The meeting will continue until September 3. There are some important questions to come up for discussion, and the programme for the meeting will soon be issued.

THE cruiser *Concord* was present at the ceremonies attending the opening of the Memphis Bridge, being the first vessel of the Navy to go so far up, the Mississippi since the War. After the opening of the bridge the *Concord* kept on up the river to Cairo; it was at first intended that she should go to St. Louis, but it was thought that the high water in the river could not be depended on for so long a trip.

THE Naval Appropriation Bill, as it passed the House of Representatives, provided, as we have heretofore noted, for only one new ship, an armored cruiser of about 8,000 tons displacement, and of the same general type as the *New York*. The Senate has amended this bill by providing also for the building of one battle-ship of 9,000 tons displacement; one harbor defense ship of the double-turret Monitor type of 7,500 tons displacement; four light-draft gun-boats of from 800 to 1,200 tons and six torpedo boats. This amendment may or may not be accepted by the House, but the probability is that there will be a compromise and that several new ships will be authorized.

ON another page will be found a description of the located line of the Western Siberian Railroad, which will be the most important part of the great line which is to connect St. Petersburg with the Pacific. The account is based upon official information, and the writer has taken an active part in the survey and location of the line.

The Siberian Railroad is certainly the longest and perhaps the most important line now under construction in the world, and it is interesting to know that work upon it has been actually begun at both ends, with the definite intention of continuing it until the road is finished.

AN attack upon the Railroad Commissioners of New South Wales has been made in the Parliament of that colony by a Mr. Hoyle, the result being the appointment of a commission to investigate. One of the principal

charges made was in relation to the purchase of locomotives from the Baldwin Works, but the evidence taken seems, so far as we have received it, to show that these engines had done excellent work, hauling much heavier trains than the other engines could on the heavy grades of the mountain lines. One of the chief witnesses was Mr. D. H. Neale, now Mechanical Engineer to the Railroad Commission, who is well known in this country, and on whose advice the Baldwin engines were ordered.

THE transmission of power by electricity is attracting much attention among engineers, owing to the successful experiments at Frankfort and elsewhere. The possibility of utilizing many water powers which have hitherto been neglected because they were remote from any possible mill site is attractive. Now that room for a small power-house is all that is required, and the power generated can be carried anywhere where it is needed by a simple pole and wire line, there will probably be a demand for water powers which have heretofore been considered useless.

ENGLISH AND AMERICAN LOCOMOTIVES.

AFTER the last of our series of articles on this subject appeared in the JOURNAL for February, our English cotemporary, *The Engineer*, published answers to them, the first of which appeared in its issue of February 26. Those of our readers who have been interested in this discussion may remember that in the JOURNAL of last November we gave a table (II) showing locomotive performance and expenditures on over 40 different railroads in this country. In our December number we called attention to the fact that our American railroad companies do not all publish any statistics which show what their average train loads are. In the same issue of the JOURNAL those lines which do report the average number of cars hauled were selected, and the average weight of trains, fuel consumed per mile, and per ton per mile were tabulated (in table V). Twelve of our main lines, which include an aggregate mileage of over 16,000 miles of road, were included in this table. The average number of cars hauled per train on these lines was ascertained from accounts which are carefully kept for this purpose, and the figures were in no sense guesswork or approximated, but were based on the accounts and reports of the different companies. The average weight of passenger trains on the 12 roads was 130.3 tons (of 2,240 lbs.), exclusive of engine and tender. The average weight of freight train on all the roads was 553.5 tons. This, it was explained, was the average of the averages on the 12 roads; the maximum average load on any one of the roads was 816.5 tons, which was on the Philadelphia & Erie.

In its article of February 26 *The Engineer* attempts to discredit these figures, and says:

> Now it so happens that there are certain official or semi-official statistics published concerning American railways. How far these are or are not trustworthy we are unable to say. It will be seen, however, that they do not at all correspond with the figures given in the preceding table. The figures are contained in a report just issued by the Inter-State Commerce Commission for the year ending June 30, 1890. In it we find that the average number of passengers in a train was 41, and that the average weight of freight trains was 175 tons, with an average haul of 120 miles per ton. There is, it will be seen, an astounding and apparently irreconcilable difference between 175 tons and 553 tons.

The astonishment of our cotemporary would, perhaps, have been assuaged if he had observed that the train-load reported by the Inter-State Commerce Commission was the average for *all* the lines in the country, which is less than that on the 12 main lines included in our table, which all have a heavy traffic. Furthermore, it is certain that the data on which the Inter-State Commerce Commission figures are based are not reliable, for the reason that comparatively few of our companies keep the requisite accounts to supply correct statistics concerning train-loads, etc. They are all compelled to report to the Commission, but when they have not the requisite data at hand, they guess at them "to the best of their knowledge and belief."

But it is our turn to be "astounded" when we find that the figures quoted by *The Engineer* from the Inter-State Commerce Commission report do not represent what our cotemporary says they do, but something entirely different. On page 51, of the report quoted from, it is said, "the number *of tons of freight* carried one mile during the year covered by the report was 76,207,047,298. . . . Freight-train mileage during the period was 435,170,812, showing the averag enumber of *tons (of freight)* per train to have been 175.12." In other words, the figures quoted by *The Engineer* represent the *lading* alone and does not include the weight of cars in the train. In our table it was explicitly stated that the figures which our cotemporary tries to discredit represented the "weight of train, exclusive of engine and tender," on the 12 roads included in the table. That there should be a very great "difference" between this average weight on the roads named and that of the *lading alone* on all the roads in the country is not surprising, but that our critic should try to disprove the accuracy of statistics which were compiled from carefully kept accounts, by quoting figures which represented something totally different from what they did mean, is "astounding."

Our cotemporary admits that "there is considerable difficulty in obtaining full information concerning the weight of passenger trains in this country (England)," and also "in getting precise figures as to the loads carried" in goods trains. It is then said that "the regular passenger train on the Caledonian Railway consists of eight coaches, and the regular goods train consists of 40 wagons." Now it is not easy to know exactly what is meant by a "regular" train on the road referred to. The trains on that line are certainly not all of a uniform size, because the writer says that some passenger trains consist of 14 or 15 cars and some coal trains weigh 629 tons. If the figures are based upon statistics kept by the railway company, why not give its figures? If they are only more or less shrewd guesses at what the average train loads are on the line mentioned, then they are valueless as evidence. After a good deal of experience in collating such data, we have been convinced that the guess or mere mental estimate of what average train-loads are of even the most experienced railroad officials, is quite valueless as evidence of what is actually done on their own lines. There are a great many light trains on all roads, which are out of sight —that is, are running on branch lines to local points, and which, if accurately accounted for, will reduce the average weight of trains. The average weight and size of trains is nearly always less than a mere observer will suppose they are. In the absence of any statistics bearing upon the subject, we discredit entirely the estimate of *The Engineer* when it says that "we believe we are justified

in stating that the average weight of main line passenger trains in Great Britain cannot be much short of 120 tons." If it has no statistics its "belief" is only a guess, and only omniscience would be sure of being right in such a case.

The data in our table V include all trains run on the roads. In comparisons of locomotive performance, general averages must be compared with general averages, and special cases with others of a like kind. A general average must include everything and not be confined to some arbitrary portion of the locomotive performance on a line, or if the special performances of locomotives are compared, the conditions must be nearly enough alike to make the comparison a fair one. As an example of unfairness, reference may be made to *The Engineer's* quotation of the average consumption of fuel by all the passenger trains of the 12 roads included in our table V during a year, which was 66.97 lbs. per train mile, and the average weight of train exclusive of engine and tender was 130.3 tons. In comparison with this it cites the Great Northern engines, which, it says, with an average weight of train hauled of 177.6 tons and speeds of over 50 miles an hour, frequently exceeding 60 miles an hour, indeed for long stretches, the consumption was but 30.6 lbs. of coal per mile, or 0.172 lb. per ton per mile. These were the best engines on the Great Northern Railroad, running under conditions which attracted the attention of all England. Engines working under like conditions always do well. For a fair comparison with the data in our table *The Engineer* should give us the coal consumption and weight of trains hauled, by not only all the locomotives on the Great Northern Railroad—good, bad, and indifferent—but on a dozen of the main lines of Great Britain. Our cotemporary is comparing a race-horse with the average daily work of hundreds of hacks, many of them old and decrepit.

In commenting on the relative weight of English and American passenger trains our cotemporary says :

> Now one of the first points which the preceding table (our table V) proves is, that the American passenger train is by no means heavier than the English train, to anything like the extent alleged hitherto by the American technical press. It amounts to only 130 tons on the average.

He says, however, further that "there is considerable difficulty in obtaining full information concerning the weight of passenger trains in this country." The weight of "the regular passenger train" on the Caledonian Railway is then given at 125 tons. The weight of the *irregular* passenger trains, including local trains, those on branch lines, etc., are not given. Our table included *all* the passenger trains on the 12 roads named. The average weight of "main line passenger trains" on the Great Eastern Railway is given at 248 tons. Again, branch line and seemingly local trains are not included. It is said though that a deduction from this weight is admissible, and 235 tons is given as probably nearer the truth than 248. Apparently this estimate is mere guesswork, and is not based on any statistical data. This hypothesis is confirmed by the fact that in its following issue our cotemporary gives the weight of an average passenger train on the same road at 166 tons, a diminution of 69 tons in one week. On the Great Northern it is said to be 170 tons. On the London & South Western it is said some trains are run which weigh 321 tons. Our cotemporary summarizes its guesswork by saying, "We believe we are justified in stating that the average weight of main line passenger trains in Great Britain cannot be much short of 120 tons." Whether this includes the weight of engine and tender is not apparent. It certainly does not include trains on branch lines, and probably not local trains either. Is it fair to compare such an average guess with the results of carefully recorded statistics which were summarized in our table V, and in which were included *all* the passenger trains on more than 16,000 miles of railroad ?

It is possible, too, to show from published statistics that some of *The Engineer's* averages are unreliable. He gives the average number of passengers carried in the "regular passenger train" of the Caledonian Railway at 120 per train, and the weight of the train at 125 tons. Now in the *Railway Returns* for 1890, published in a Parliamentary blue-book, the number of miles traveled by passenger trains on this road is reported as 6,926,813, and the gross receipts from passenger traffic £988,921. Dividing the latter by the former gives 34¼*d.* as the average receipts per train-mile, and dividing this by 120, the average number of passengers carried, gives 0.285*d.*, or 0.57 ct. as the average receipt per passenger per mile. Now, does the writer in *The Engineer* seriously believe that the Caledonian Railway Company carried all its passengers for a whole year at that average rate ?

Another deduction is possible from the *Railway Returns*. In 1890 the number of miles traveled by passenger trains in Great Britain was 158,214,555 miles, and the gross receipts from passenger traffic were £27,961,645. Dividing the one by the other gives 42.4*d.* as the receipts per mile, and dividing this by 120, the average weight of trains, will give a trifle over 0.7 ct. as the amount received for hauling passenger trains per ton per mile. If this really represents the cost of that service, it may be a question whether it would not be advisable to carry goods and coal in passenger trains on British roads.

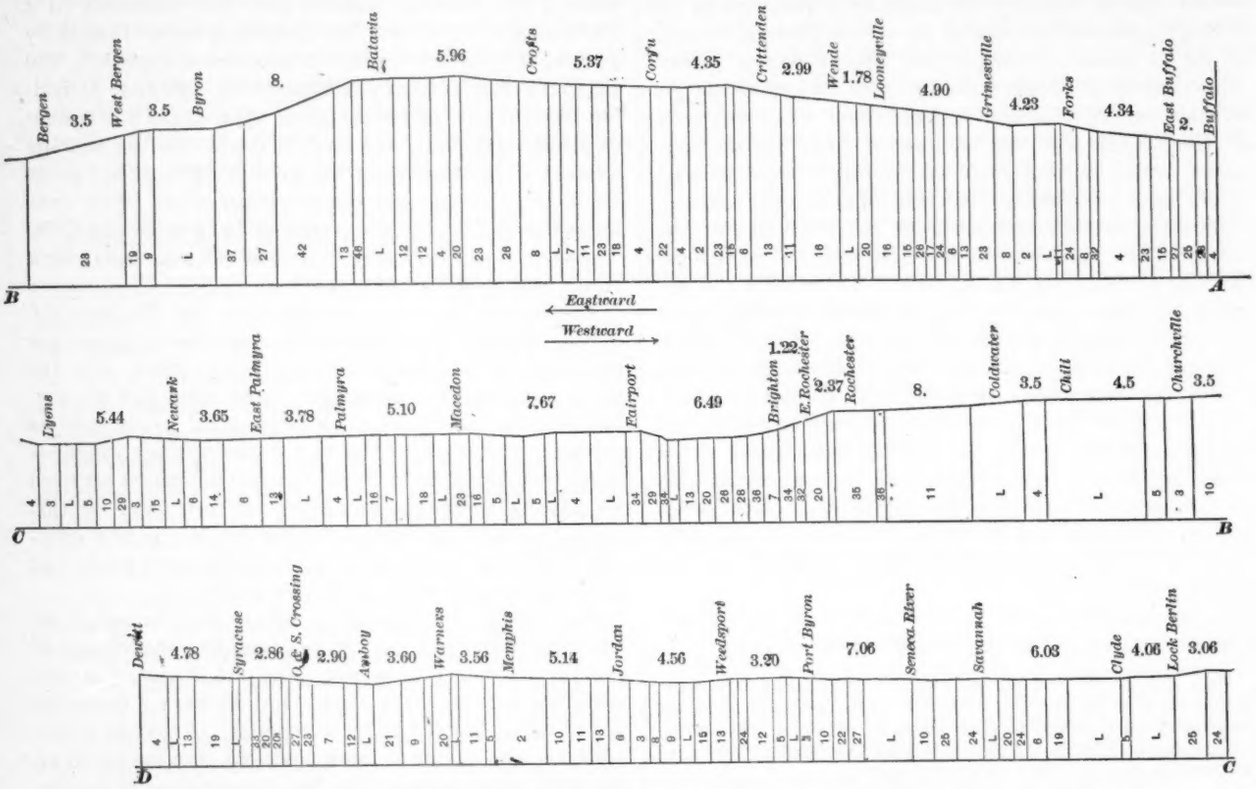
But taking *The Engineer's* figures for the weight of passenger trains and the average English consumption of coal per passenger train-mile, which, it is said, "is certainly not over 36 lbs. a mile," and we have a consumption of 0.3 lb. per ton of train per mile. Referring to our table IX, and it will be seen that with one exception all the roads which reported the fuel consumption in hauling their heavy passenger trains show a lower rate of consumption than *The Engineer's* average on British roads. The rates, per ton per mile, given in the table referred to are 0.299, 0.298, 0.289, 0.274, 0.268, 0.257, 0.248, 0.227, 0.215, 0.197, 0.194, 0.183, 0.171, 0.166, and 0.146. The exception is the Baltimore & Ohio road on its heavy mountain grades, and on its fast train between Baltimore and Philadelphia, the second fastest train in the country, which burns 0.385 lb. per ton per mile.

It may be said though that this is comparing what *The Engineer* is pleased to assume as the average consumption on British roads, with special trains on American roads, which would be true if our cotemporary's figures represented general averages, which we have shown they do not. But if we take the coal which is allowed on the Pittsburgh, Fort Wayne & Chicago road for running their passenger trains, which is somewhat in excess of the actual consumption—because some of the men are paid a bonus or premium for what they save out of the coal allowed—and we find that the amount is only 0.33 lb. per ton per mile, and on some trains as low as 0.19. Surely *The Engineer* must revise its statement that American locomotives burn nearly double the quantity of coal that

English engines do. If it could or would obtain any reliable statistical data concerning the average weight of *all* trains on its roads, then some comparison of general averages which would be conclusive might be possible, but mere conjecture is not proof.

Concerning freight trains *The Engineer* admits that they are considerably heavier in the United States than they are in its own country. "But," it is said, "on the other hand, they are run at slower speeds. In England speeds of 30 miles an hour are frequently exceeded by goods trains; even mineral trains are run now and then at that velocity."

Evidently the writer of what we have quoted is unacquainted with the practices which exist on some of our single-track lines with heavy traffic. The speed of a freight train on such roads is not likely to be strictly limited to any given speed when there is an express train before and another behind, which will be delayed unless the freight gets out of the way. Thirty miles an hour is quite a common speed for freight trains on nearly all of our roads.



PROFILE OF WESTERN DIVISION, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

NOTE.—The figures above the base line indicate the rate of grades in feet per mile.

In our table VII, published in December, in which the results of tests of freight locomotives on the North British and the New York Central Railroads were compared, the average weight of the cars and lading of the trains hauled on the latter line, it was stated, was 1,212 tons, and the maximum grade was 42 ft. per mile. *The Engineer* calls attention to the fact that it is impossible for a locomotive of the weight and dimensions given to haul a train of that weight up a grade of 42 ft. per mile. In this our cotemporary is right, and whatever controversial advantage accrues from the fact that in the report of these tests, which we quoted from, there was no intimation that a helping engine was used, and that we had no knowledge of that fact, and neglected to calculate the capacity of the engine, our cotemporary may rightfully claim. We have carefully inquired into the conditions under which the tests were made, and have found that an assisting engine was used in the westward trips from Byron to Batavia, a distance of eight miles. The accompanying profile shows the contour of the line on which the tests were made. No helping engine was used on the eastward runs, and unfortunately no account was kept of the fuel consumption of this helping engine, nor was the fuel consumption during the eastward and westward runs kept separately. No correction of our figures is therefore possible. As the engine on the North British road burned nearly 2½ times as much coal per ton of load hauled as the New York Central engine, and as the total cost of locomotive expenses and train service per ton hauled of the former engine was more than four times that of the latter, there is ample margin for making any correction due to the use of the helping engine for a distance of only about 2½ per cent. of the whole distance run.

The writer in *The Engineer* also calls attention to the fact that Mr. Buchanan's engine on the New York Central road burned only 0.105 lb. of coal per ton per mile, the average consumption on the 12 roads reported in our table V burned 0.215 lb. To any one who has ever studied locomotive reports this will not cause surprise. The roads named in table V own nearly 5,000 locomotives, and the consumption of coal reported therein is that of all of these engines, good, bad, and indifferent, and working under all sorts of conditions, grades, curves, etc., favorable and unfavorable. It illustrates the importance in comparisons of this kind, as has been mentioned before, of confining

them either to general averages or to special tests made under like conditions. *The Engineer* constantly confuses these two kinds of data, and, in fact, seems to have a misapprehension of the meaning of the word "average" when it is used in the sense of a medial sum or quantity. Thus, in speaking of the average weight of English goods trains, he says that we are mistaken in thinking that 233 tons represent about the average English goods trains. "Coal trains of 450 tons," he says, "are very common in this country, and if we grant that 60 lbs. per mile is burned with such trains, we have less than 0.14 lb. of coal per ton-mile, which is not greatly in excess of one-half that burned by American engines."

But why should we grant *The Engineer's* assertion? He does not give the slightest evidence to lead us to do so. But even if *some* engines pull trains of 450 tons weight with a consumption of 60 lbs. of coal per mile, it does not prove that *all* freight trains on English roads burn that amount of fuel per ton per mile. The reasoning is feeble and fallacious. It is a case of what logicians call a "non-distribution of the middle term."

In the article which appeared in *The Engineer* of March 4, our cotemporary, commenting on some of the data which we gave in our table IX* showing the maximum loads hauled, with weight and performance of locomotives, on different American railroads, says:

It must be clearly understood that this table does not represent average performance. It shows the heaviest loads hauled, and some of the figures given cannot be received without considerable hesitation. Let us take, for example, the New York Central train. This, according to the table, weighs 392 tons; the weight of the tender is, we assume, included in this. The engine weighs about 44 tons. So the gross load moved is 436 tons. The tractive power of the engine is, in round numbers, 105 lbs. per pound of average cylinder pressure; the speed is over 37 miles per hour. The resistance at this speed cannot, we think, be less than 20 lbs. per ton, and $436 \times 20 = 8{,}720$ lbs., demanding an average pressure of about 83 lbs. effective in the cylinders. A resistance of 8,720 lbs. overcome at the rate of 3,256 ft. per minute represents 860 horse-power expended in hauling alone. But experiments very carefully conducted in the United States have shown that the indicated power is not infrequently twice as great as that represented by the pull on the draw-bar. If, however, we make the very moderate estimate that the power expended in the internal resistances of the engine was but 140 horses, we have 1,000 horses left, as the average indicated power of the locomotive. Unfortunately the consumption of fuel per mile is not given. That of a larger engine is, however, given lower down at 95 lbs. per mile. Assuming that the New York and Albany engine burned the same weight, we have $37 \times 95 = 3{,}515$ lbs. of coal for an hour's work, and 3.515 lbs. only per horse-power per hour. But it is a liberal estimate to say that the boiler made 7 lbs. of steam per pound of coal, so that notwithstanding the enormous average pressure, which must have greatly limited expansion, the engine was running with only 24.6 lbs. of steam per horse per hour. This is indeed a wonderful performance altogether—so wonderful that our cotemporary ought to investigate the facts. If it can be really proved that the figures he gives represent the truth, then the New York and Albany locomotive deserves to be reproduced over and over again. As it is, without meaning to be discourteous, we are compelled to say that the figures cannot possibly represent facts without qualification.

It is not easy to know just how to discuss a subject with a person in the condition of mind which is manifested by the close of the above paragraph. A reply thereto should be preceded by the statement that the Hudson River Division of the New York Central Railroad is nearly level from New York to Albany. There are some short grades of from 15 to 34 ft. per mile, but they are so short as not to materially affect the capacity of engines, and others of 9 to 10 ft. per mile and 2 or 3 miles long. Now the engines specified in our table have taken trains of the size and weight from New York to Albany in the time named, and we are authorized by Mr. Buchanan, the Superintendent of Machinery of the road, to say that if the Editor of *The Engineer* will visit this country or send a representative, he, Mr. B., will take great pleasure in hauling such a train from New York to Albany with one of the engines specified in our table, and with his foreign visitor as a passenger.

Esteemed cotemporary, it is not our figures which "cannot possibly represent facts," it is yours. You have assumed that the resistance of the passenger cars on the Hudson River Railroad cannot be less than 20 lbs. per ton at a speed of 37 miles per hour. It is probably less than 15 lbs.

Again, our cotemporary discredits the fact, given in our table IX, that Mogul engines on the New York Central Railroad haul trains from Buffalo to New York, a distance of 440 miles, which weigh 1,800 tons. Of this performance *The Engineer* says:

The table of freight trains presents many figures with which we in Great Britain have nothing to compare. As, for example, 1,800 tons hauled at 29 miles an hour. It is, we think, beyond question that the resistance per ton of goods trains is greater than that of passenger trains at moderate speeds, because the wheels are not kept in such good order, the axle-boxes are less carefully lubricated, and there is more jolting and striking of flanges against the rails. We shall probably not be over the mark—though we are open to correction—if we take the resistance of engine and train together at 20 lbs. per ton. But this means a resistance of 36,000 lbs., and this resistance overcome at the rate of 1,760 ft. per minute represents about 1,900 horse-power. A small addition for internal resistance gives us 2,000 indicated horse-power. The engine has cylinders 19×26, and its tractive power is in round numbers 147 lbs. per pound of average pressure, so the average pressure cannot have been less than 244 lbs. on the square inch. We willingly admit that we have nothing in this country at all comparable with this. If it be argued that 20 lbs. is an excessive resistance, then it is clear that goods trains run with much less friction than passenger trains. A great road resistance is the only excuse for the enormous consumption of fuel in passenger engines. Why should not the same resistance exist for goods trains? We have not said anything about the weight of the engine in this case, which amounts to about 53 tons—a trifle, of course, compared to the weight of the train. Once more we have to plead incredulity. We really cannot manage to believe that a locomotive of the dimensions stated hauled 1,800 tons at 30 miles an hour, especially as there is a maximum grade of 30 ft. to the mile, or 1 in 176 to be dealt with, but whether the train went up this or down is not stated. Nothing is said about the weight of the coal burned.

It is true that a correction of our statement is required. On more careful inquiry than was given to the first report which was received of this performance, we find that pushing engines are used at four places between Buffalo and New York: first, from East Buffalo to Forks, a distance of 4½ miles; second, on the grade west of Fairport, a distance of 1 mile; third, east of Oneida, 1 mile; and fourth, from Schenectady to Athens Junction, for 3½ miles. The whole distance from East Buffalo to New York is 440 miles. On reinvestigation we find, however, that our estimate of the average weight of cars hauled in these trains is below and not above the actual weight. Many of the cars carry over 50,000 lbs. of lading, and the cars themselves weigh 30,000 lbs. With the exception of the places named, such trains are hauled daily on the New York Central line by Mogul engines of the weight and dimensions given in our table.

Since our former articles were written we have received reports of other heavy trains hauled on different roads, the data of which are given in the accompanying table. These

* Published in February.

TABLE SHOWING THE MAXIMUM LOADS HAULED, WITH THE WEIGHT AND PERFORMANCE OF LOCOMOTIVES, ON DIFFERENT AMERICAN RAILROADS.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Name of Road.	Terminal Points.	Distance between Terminals.	Number of Loaded Freight Cars Hauled.	Number of Empty Freight Cars Hauled.	Number of Mail, Baggage, Express or Postal Cars Hauled.	Number of Coaches Hauled.	Number of Drawing-Room, Sleeping or Dining Cars Hauled.	Total Number of Cars Hauled.	Weight of Cars and their Loads in Tons of 2,240 Lbs.	Maximum Grades on Run.	Schedule Time, including Stops.	Kind of Engine Employed. ‖	Total Weight of Engine in Working Order.	Total Weight on Driving-Wheels.	Diameter of Driving-Wheels.	Size of Cylinders.	Coal Consumed per Mile.	Coal Consumed per Ton of Train Exclusive of Engine and Tender.	Proportion of Weight of Engine to Weight of Cars Hauled.	Miles per Hour.
		Miles.							Tons of 2240 lbs	Ft. per m.	H. M.		Lbs.	Lbs.	In.	In.	Lbs.	Lbs.		
PASSENGER TRAINS.																				
Baltimore & Ohio	Baltimore & Martinsburg	114	...	...	4	3	3	10	.....	.....	2 56*	Am.	102,000	70,000	66	19 × 24	.....	.....	.....	....
" "	Piedmont & Altamont	17	....	.. ..	2	2	1	5	.....	117†	.. 43½	"	102,000	70,000	68	19 × 24	.....	.....	.....	....
" "	Sandusky & Newark	115.6	....	.....	1	18	....	19	485¼(a)	48‡	4 32 (c)	10-wheel.	127,500	101,500	60	20 × 26	.....	.....	8.5	....
" "	Newark & Columbus	33	....	.....	1	18	..	19	485¼	47§	1 05 (d)	"	127,500	101,500	60	20 × 26	.....	.....	8.5	....
" "	Columbus & Newark	33	....	.....	1	18	..	19	485½	51 (b)	1 27 (e)	"	127,500	101,500	60	20 × 26	.....	.....	8.5	....
" "	Newark & Sandusky	115.6	....	.....	1	16	....	17	435½	.....	6 5 (f)	"	127,500	101,500	60	20 × 26	.....	.....	7.6	....
Phil. & Erie Div., Penn. R R., and Nor. Cent. R.R.	Harrisburg & Williamsport	93	....	.....	4	4	3	11	256.8	10.8	3 20	Am.	103,600	65,400	68	18 × 24	59.13	.83	5.5	....
Chicago, Milwaukee & St. Paul	Milwaukee to Chicago	85	..	.....	3	3	5	11	412.5	35	2 30	"	100,000	64,100	69	18 × 24	....	.....	9.2	....
FREIGHT TRAINS.																				
Chicago, Milwaukee & St. Paul	Milwaukee & Chicago	85	35	.....	....	....	....	....	906.2	35	(h) 6 ..	Am.	100,000	64,100	....	....	.....	.....	20.3	....
" "	" " "	85	43	.....	...	....	....	....	1170	35	(h) 6 ..	10-wheel.	117,000	84,800	....	....	.....	.....	22.4	....
Phil. & Erie Div., Penn. R.R., and Nor. Cent. R.R.	Sunbury to Honey Pot	53.5	83	45	....	...	....	...	1077.9	22.7 (g)	5 20	C'nsolidat'n	95,700	82,700	50	20 × 24	199.06	.185	25.2	....
"	Rockville to Sunbury	46.7	26	72	....	....	....	....	1180	8.7 (g)	4 10	"	95,700	82,700	50	20 × 24	256.95	.200	20.9	....
"	Honey Pot to Sunbury	53.5	65	....	....	....	....	....	1788.2	30.6 (g)	4 32	"	95,700	82,700	50	20 × 24	199.06	.111	41.8	....
"	Sunbury to Rockville	46.7	75	... .	....	...	....	....	2422	7.5 (g)	4 20	"	95,700	82,700	50	20 × 24	329.76	.132	56.7	....
"	Honey Pot to Sunbury	53.5	75	.....	....	....	....	....	2764.7	22.7 (g)	4 32	"	124,800	110,000	50	20 × 24	340.6	.123	49.6	....

* Including 4 stops. † This grade is continuous for 17 miles with sharp curves. ‡ This is the maximum grade for a distance of 3 miles. § This grade is 4 miles long. (a) This includes the weight of 1,325 passengers in the train. (b) Grade about 6 miles long. (c) Including 11 stops. (d) Including 1 stop. (e) Including 1 stop. (f) From Newark to Sandusky the train was run as an extra, and took side tracks for all regular trains. (g) The grades on this portion of the road, although the number of feet per mile exists for short distances of from 500 to 1,400 feet; in other words, the road has a number of short dips, but the general character of the grade is gradual descending from Honey Pot to Sunbury, following approximately the fall of the Northwest branch of the Susquehanna River. The road is very crooked over most of the distance, so that the curve resistance is in most cases more serious than the short grades. (h) Have 2 grades of 35 ft. per mile. Freight trains have a pushing engine up the first one, 2½ miles long, but none up the second one, which is 1½ miles long.

reports are given on the authority of the Superintendents of Machinery of the lines on which the trains were hauled. It will be seen from this that a passenger train weighing 485¼ tons was hauled on the Baltimore & Ohio Railroad, and on the Philadelphia & Erie freight trains of 2,422 and 2,764.7 tons have been hauled with consolidation engines. This line, it may be said, is nearly level, with a few grades and a slight descent in the direction in which the trains were hauled.

But our esteemed adversary has reserved its most overwhelming argument for the last. To explain the fact, which we have proved by statistics, that American locomotives run farther, pull heavier loads, and cost less for repairs, he says they must therefore wear out sooner. Surely it cannot be expected that we will seriously answer such reasoning. Esteemed cotemporary, how do you know they wear out sooner? who told you they did? or—what is probable—did you only imagine they do? what evidence have you to show that they are short-lived? There are locomotives in this country which have been in continuous service for over fifty years. Are there any English engines of that age in service? No table of mortality has ever been constructed to show an average "prospect of life" of American locomotives; but, esteemed cotemporary,

seriously, if they wear out faster the expense of renewals ought to show in the repair accounts, because all companies, in this country, which keep their accounts properly, charge renewals of old engines to "repairs." Now, as the repairs of our engines cost less than yours do —even with more costly material and higher wages—it would seem to show that in reality they are longer-lived than yours. You say that we "do not attempt to explain why an American locomotive should last longer and cost less for repairs than its English rival." We can't explain the reason for a fact which does not exist. It is perhaps not very important either that it should be explained to parties like the Indian Locomotive Superintendent, whose letter is published on another page, provided the fact is proved, as we think it has been in these articles. In the future we hope to be able to make what we may call anatomical comparisons of the details of a representative English and American locomotive. We have been promised complete drawings of an English and of a corresponding America express engine, and as soon as they are received we intend to give our readers engravings of them and will then discuss the comparative anatomy of the two breeds of machines. Until then you and some other Englishmen and we and all other Americans may repose in the conviction expressed at the end of your discussion of this subject, that "Our locomotive is adapted to our requirements, and the locomotive of the United States to the requirements of Brother Jonathan." But how about the railroad managers

"From Greenland's icy mountains,
To India's coral strand,
or Where Afric's sunny fountains
Roll down their golden sand"?

—those are the people who are, or should be, open to conviction, and who will be interested in knowing that this discussion has shown that American locomotives *run farther in a given time, pull more, cost less for repairs, burn less fuel in proportion to the loads hauled, and last longer than English locomotives do.*

NEW PUBLICATIONS.

THE COAL TRADE. *A Compendium of Valuable Information Relative to Coal Production, Prices, etc.* By Frederick E. Saward. The *Coal Trade Journal*, New York.

This is the nineteenth number of Mr. Saward's very useful annual publication. It is what the title claims—a compendium of information relating to the coal trade, giving production, range of prices, and a great deal of other useful information.

The statistics given seem to be the best available. For the anthracite coal field and for some of the Eastern bituminous districts—such as the Clearfield, Cumberland, and a few others —complete figures are attainable for production and shipments; but for many of the Western coal fields it is impossible to give more than approximate and estimated statements. Mr. Saward's long experience in the trade has enabled him to make an excellent book, and to know where to look for the most reliable information, and it is an indispensable book of reference for all who are connected with or interested in the trade.

A TEXT-BOOK ON RETAINING WALLS AND MASONRY DAMS. By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. John Wiley & Sons, New York; price, $2.

This book is intended for the use of civil engineers, as well as for a text-book for students, and its author's object has evidently been to treat his subject in as brief and compact a way as would be consistent with clearness. It includes chapters on Earthwork Slopes; Lateral Pressure of Earth; Investigation of Retaining Walls; Design of Retaining Walls and Masonry Dams. The various principles and formulas stated are illustrated by numerical examples in almost every case.

The book sets forth the best methods of computing the thrust of earth against walls, of investigating strains on walls and dams, and of designing structures of that kind. It is concisely and yet clearly written, for Professor Merriman has always the gift of expressing his meaning plainly, and is altogether an admirable text-book on a somewhat difficult subject.

TRADE CATALOGUES.

Bending and Straightening Rolls for Iron and Steel Plates: Illustrated Catalogue. The Niles Tool Works, Hamilton, O.

This catalogue gives descriptions of a number of tools of the class named, including some very heavy and powerful machines, built especially for bending ship and armor plates of the largest size. It is very handsomely illustrated.

Griffith's Stopper and Nozzle for Open-hearth and Bessemer Steel Ladles. R. B. Seidel, 1324 Callowhill Street, Philadelphia.

This is an illustrated description of an excellent device, which was described in the JOURNAL some time ago, and which has now proved its usefulness in service.

Illustrated and Descriptive Catalogue of the Nathan Manufacturing Company: New York.

This very handsome catalogue is the first issued by the Nathan Company for several years, and it contains descriptions of several new devices which were not in the last edition. These include a steam fire extinguisher; a steam sanding apparatus; a boiler washer and filler; and the new "Nathan" injector, which we expect to illustrate shortly in our columns. The illustrations are very good, and the catalogue generally is an exponent and example of the excellent work for which the Company is noted.

Comparative Boiler Tests at the Rochester (N. Y.) Railway Company. The Heine Safety Boiler Company, 421 Olive Street, St. Louis.

This is an account of some competitive tests of safety boilers made recently in Rochester, N. Y., with the object of determining the efficiency of the Heine boiler as compared with others of the same type.

Brass and Iron Goods and Specialties: Illustrated Catalogue of the Lunkenheimer Brass Manufacturing Company, Cincinnati, O.

This catalogue contains descriptions of a great variety of articles, including valves of all kinds, fittings, oil-cups, etc., including a variety of specialties, such as the "handy" gate valve; sight-feed lubricators and other devices. The Company represented by the catalogue has a very large plant, and facilities for doing a great variety of work.

The Acme Water Lift: Illustrated Catalogue. Burt & Skilton, Patentees, Jacksonville, Fla.

This is an illustrated description of a device for raising water, which has been heretofore described in the JOURNAL, and which is very well adapted for railroad use, especially at stations where it is not convenient to keep a steam-pump or engine. Water can be raised and tanks filled readily by passing locomotives.

Illustrated Catalogue of Graphite Productions. The Jos. Dixon Crucible Company, Jersey City, N. J.

This catalogue gives one a new idea of the variety of purposes to which graphite can be applied. The Jos. Dixon Company is a leader in this branch, and has not only supplied graphite in its purest form, but has made for years a study of the different methods of using it in the arts. The catalogue should be studied, for it is quite impossible to give more than a general idea of its varied contents within the limits of a brief notice.

The Improved Drawing Table and the Multilinead: Illustrated Description. John Svenson, M.E., Scranton, Pa.

CURRENT READING.

In the June number of the POPULAR SCIENCE MONTHLY Mr. Andrew D. White continues his articles on the Warfare between Science and Theology. Professor John S. Newberry contributes a sketch of the Ancient Civilizations of America, and Mr. A. Morgan writes of the necessity of a Railroad Court of Last Resort to construe the many and frequently conflicting National and State laws relating to railroads. There are also several other interesting articles.

In the FORUM for May the Silver Question is discussed by Senator Vilas, Representative Harter and Mr. J. C. Hemphill, of Charleston. Mr. S. C. T. Dodd pleads the cause of the Standard Oil Trust, and Mr. D. R. Wilkie, General Manager of the Imperial Bank of Canada, discusses the advantages of the Canadian Banking System. An article of especial interest to engineers is Mr. Edward P. North's paper on Ocean Traffic by the Erie Canal. Mr. North groups his statistics well and makes a plea for the enlargement of the Erie Canal which is in some respects effective, but is unfortunately marred by some defective reasoning; it is, however, a readable paper.

With the May number the ARENA completes its fifth volume. In the two and a half years of its existence this magazine has been remarkably successful, simply because its editor has adhered closely to the original intention of keeping its pages open to the free and full discussion of important questions. It has enlisted many contributors of ability, and has taken a high position on this account. The May number is fully up to the high standard set, and promises continuous improvement.

Several very finely illustrated articles are found in HARPER'S MAGAZINE for June, and the number contains even more than the usual variety. The Austro-Hungarian Army is described by one of its officers. The paper in the Western series is on Montana, and there is one on Eastern Peru, a country almost unknown to most of us. The lighter part of the magazine is appropriate for an early summer number.

The June number of the OVERLAND MONTHLY is a very good one, both in matter and illustrations, and shows that this magazine is keeping up to a high standard.

The May number of OUTING is bright and brings with it a pleasant suggestion of coming summer. The Bicycle, Riding, Canoeing, Fishing and Hunting all find place in its columns, and there are some excellent illustrations. The evolution of the new form of fast yacht is traced in a carefully written article. The Maryland National Guard is the subject of the military article for the month.

The number of the COMMERCIAL AND FINANCIAL CHRONICLE for May 21 is accompanied by the yearly SUPPLEMENT giving State and city debts. This is the only publication giving full information about issues of State and municipal bonds; it is prepared with great care and is of the highest value to investors, with whom this class of securities is very popular.

Among books in preparation by John Wiley & Sons, New York, we note a new volume on GEODETIC SURVEYING by Professor Mansfield Merriman.

In recent numbers of HARPER'S WEEKLY there have been illustrated articles on the Memphis Bridge; on the Mining Regions of Alaska; on the Columbia River Centennial, and a number of other interesting topics.

The May number of the ECLECTIC MAGAZINE has an excellent selection of articles from the leading English periodicals, including two or three that deserve especial attention.

The May number of the ENGINEERING MAGAZINE has some interesting articles, including illustrated papers on the Future World's Highway, by T. G. Gribble; Difficulties of Tunnel Building, by Emil Low; Education for the Workshop, by F. A. C. Perrine; Water Supplies for Cities and Towns, by Floyd Davis. The special departments have been put in editorial charge of gentlemen who are experts in their several subjects.

A number of excellent articles are found in GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for May. Among the subjects treated are Glaciers; the Appalachian Mountains of Pennsylvania; River Valleys; Volcanic Forces and Submarine Cables; the Physiology of a Pocoson, and the history of Columbus. The number has general as well as special interest and is bright and readable.

In the June number of SCRIBNER'S MAGAZINE Mr. Thomas C. Clarke has an article suggesting a solution for the problem of rapid transit, especially in New York, Boston, and Chicago. Other articles describe an ascent of Mt. Etna, the Chicago fire of 1871, and the great Texas Cattle Trail, which has now almost disappeared. There are also some other articles of interest, besides the usual amount of fiction and lighter material.

In the May number of GOOD ROADS Mr. J. M. H. Frederick has a paper on the Roads of Ohio, which is illustrated by some very striking photographs of country roads of various degrees of badness. There are also papers on Broad Tires, on Dirt Roads and Gravel Roads, and several other timely topics.

The May number of MINERALS has articles on Mount Mica; on New Minerals discovered; on the Origin of Diamonds; on Minerals of Spanish America; Minerals at the World's Fair; and a variety of shorter notes on various topics.

BOOKS RECEIVED.

Ninth Annual Report of the Board of Railroad Commissioners of the State of New York for the Year ending June 30, 1891. William E. Rogers, Isaac V. Baker, Jr., Michael Rickard, Commissioners. State Printers, Albany, N. Y.

First Report of the United States Board on Geographic Names. 1890–91. Government Printing Office, Washington.

United States Naval Institute: Additions, Changes and Corrections in Instructions for Infantry and Artillery, United States Navy, 1891. Published by the Institute, Annapolis, Md.

Liste des Batiments de la Marine Française (Guerre et Commerce) et de Leurs Signaux Distinctifs. Janvier 1, 1892. Service Hydrographique de la Marine. Imprimerie Nationale, Paris, France.

Second Annual Report of the Board of Directors of the Pittsburgh, Cincinnati, Chicago & St. Louis Railroad Company; for the Year 1891. Pittsburgh.

The Railroads and the Public: Addresses delivered before the Contemporary Club by George G. Crocker, Joseph D. Potts, Joseph S. Harris and George B. Roberts. Privately printed for the Contemporary Club, Philadelphia.

Annual Report of the City Engineer of the City of Providence for the Year 1891. *J. Herbert Shedd, City Engineer.* Issued by the City, Providence, R. I. This report contains much valuable information, to which we hope to refer at more length hereafter.

Catalogue of the Officers and Students of Washington University, with the Courses of Study for the Academic Year 1891–92. Issued by the University, St. Louis.

Report of the United States National Museum under the Direction of the Smithsonian Institution. Government Printing Office, Washington. Some reference has heretofore been made to this report.

University of Wisconsin: Circular of the College of Mechanics and Engineering. Published by the University, Madison, Wis.

Tenth Annual Catalogue of the Rose Polytechnic Institute; with an Outline of the Course of Study and the Plan of Instruction. 1892. Issued by the Institute, Terre Haute, Ind.

Proceedings of a National Convention of Railroad Commissioners, held at the Office of the Interstate Commerce Commission, Washington, D.C., April 13 *and* 14, 1892. Washington; issued by the Interstate Commerce Commission.

Statistical Abstract of the United States: Fourteenth Number, 1891. *Finance, Coinage, Commerce, Immigration, Shipping, Postal Service, Population, Railroads, Agriculture, etc. Prepared by the Bureau of Statistics under the Direction of the Secretary of the Treasury.* Government Printing Office, Washington.

The Americus & Tampa Railroad Company: Prospectus. Compiled by Judge Joseph Tillman, President. Issued by the Company, Americus, Ga.

Annali della Societa degli Ingegneri e degli Architettti Italiani: Anno VII, 1892, *Fascicolo I.* Issued by the Society, Rome, Italy.

Design Patents: Liability of Infringer. United States Circuit Court Southern District of New York. Opinion of Judge Coxe in the case of Untermeyer vs. *Freund and others.* New York.

THE INTERCONTINENTAL RAILROAD SURVEY.

THE first surveying party for the Intercontinental Railroad, which is under charge of Mr. W. F. Shunk, has completed a preliminary survey from Quito in Ecuador to Medellin in Colombia, and has recently been instructed to continue the line from the last-named point to Cartagena, with especial reference to determining the best practicable route.

The party under charge of Mr. W. D. Kelly is now at Cerro di Pasco in Peru, and is about to begin the survey of a line from that place to Cuzco and thence southward into Bolivia.

These two surveys, when completed, will, with those already made, determine the practicability of the Intercontinental Line from Cartagena to a connection with the Argentine railroad system, and will cover nearly all the proposed line in South America. The preliminary work will probably be finished within a year.

Something depends, of course, on the money which may be available for the work; but it is understood that there is now little doubt that a sufficient appropriation can be secured for the present year. The work completed so far covers about 1,600 miles of reconnoissance, and some 500 miles more are included in the two sections mentioned above.

SOME CURRENT NOTES.

THE Governor of New York has signed the bill passed by the Legislature which provides that 10 hours' work performed within 12 consecutive hours shall be considered a day's work for railroad men. For all over the 10 hours' work they are to be entitled to extra pay. It is further provided that no trainman who has worked 24 hours shall be required to go on duty again until he has had at least eight hours' consecutive rest. A fine not to exceed $500 is the penalty for any violation of the law, and the only exception permitted is in clearing tracks in cases of accident.

SOME trials have been begun at the New York Navy Yard with the torpedo-boat *Destroyer*, which was built some years ago. This boat was built for the purpose of testing the Ericsson submarine gun, which is intended to throw a formidable projectile under water. The boat itself is 130 ft. long and 10 ft. beam; the gun is fixed firmly in the hull and is about 30 ft. long, with a caliber of 12 in. The projectiles are cylinders nearly 20 ft. long, provided with fins for directing their course, and carrying a heavy charge of explosive. This gun was one of the last inventions of the late John Ericsson, and from it he expected great results.

THE report of the State Engineer of New York gives an interesting history of the canal system of the State and its gradual development. It states that the improvements now in progress on the Erie Canal, the main trunk of the system, will give a full depth of 7 ft. of water throughout; this depth is at present reduced at several points by deposits of mud and silt. The locks are all to be made long enough to pass two boats, the general practice on the canal being to run two boats together. A steady increase in the number of steam canal-boats is reported.

THE Kansas City, Watkins & Gulf Railroad was completed on April 28 from Lake Charles, La., to Alexandria, a distance of 96 miles. This road has been located and built under the direction of Mr. P. H. Philbrick, Chief Engineer, and required some difficult work.

THE Chicago Elevated Terminal Railroad Company has had plans prepared for a large station building on the corner of Twelfth and State streets in that city. The main building is to be 269 × 350 ft. and eight stories high, and on the street corner there is to be a tower 60 ft. square and 420 ft. high. In the rear of the main building there will be a train-shed 269 × 1,000 ft., with 14 tracks and eight platforms. The main building will contain waiting-rooms and all necessary accommodations, and on the ground floor there will be a number of stores. The estimated cost of the building is $3,500,000 in all.

THE Rensselaer Polytechnic Institute at Troy has secured the services of Mr. Alphonse Fteley, Chief Engineer of the New York Aqueduct Commission, and of Mr. J. J. R. Croes to deliver lectures to its students during the next term.

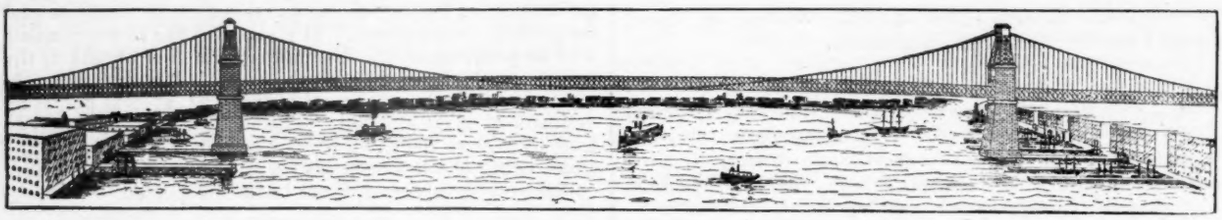
A valuable collection of pamphlets relating to the construction and operation of the New York and Brooklyn Bridge has been presented to the library of the Institute by two of its graduates, Mr. C. C. Martin, now Chief Engineer, and Mr. G. Leverich, Principal Assistant Engineer of the Bridge.

THE Tramways Trust of the city of Melbourne, Victoria, began operations eight years ago, when there were no cable lines in Australia, and the only one in the colonies was a short line in Dunedin, New Zealand. The Trust now owns in Melbourne 43½ miles of cable road and 3½ miles of line operated by horses. The whole system has been constructed under the charge of Mr. G. S. Duncan, Chief Engineer, and that gentleman was recently presented with a handsome testimonial, on the occasion of his starting for a trip to England and the United States.

PLANS for the new bridge which the East River Bridge Company proposes to build between New York and Brooklyn, under the charter recently obtained from the

New York Legislature, have been prepared by Chief Engineer George B. Cornell, and have been approved by the Directors of the Company. The location of the bridge is about one mile further up than the present Brooklyn Bridge, and it will extend from a point near Delancey Street in New York to South Fifth Street in the Eastern District of Brooklyn. On the New York side the approaches will extend to a point near Willett Street, and it is proposed to continue an elevated railroad line from that point to the Bowery, connecting with the Second and Third Avenue lines of the Manhattan Company.

The plans provide for a suspension bridge of the same general character as the present Brooklyn Bridge. The piers will be of granite and will stand on the dock line provided by the City authorities. The top of the piers will be 280 ft. above the river. The masonry work will be carried up about 180 ft., and the remaining 100 ft. will be a steel structure. The main span between the piers will be 1,620 ft., or 25 ft. longer than that of the Brooklyn Bridge. The clear height above high water at the piers will be 120 ft., and in the center 135 ft. The width of the roadway, including side-walks, roadway for teams and four tracks for cars, will be 106 ft. The cables for the bridge will be four in number, and will be 19 in. in diameter.



DESIGN FOR NEW BRIDGE OVER THE EAST RIVER, NEW YORK.

As in all city structures of this kind one of the greatest sources of trouble and expense will be the right of way for the approaches and the land needed for the anchorage structures for the cable. It is stated that the officers of the Company are now engaged in securing the required property. The engineers are employed in making the necessary surveys and the borings to ascertain the character of the bottom at the points where the piers are to be built.

THE specifications for the new dry-dock at the New York Navy Yard are completed, and bids for its construction are to be received till July 12. It will be near the present timber dock.

When completed it will be the largest dock in this country. It will be 625 ft. long on the outside, 154 ft. wide at the top, 64 ft. wide at the bottom and 28 ft. deep. The foundation piers must be driven 45 ft. below the bottom of the dock. A bed of concrete not less than 2 ft. thick will cover the heads of the piles. The dock floor will be laid on stringers of yellow pine, secured to the foundation piles by bolts driven in the center of the piles.

The dock will be closed with a steel floating gate or caisson. The caisson will be 108 ft. in length at the top and 71 ft. long at the bottom, 25 ft. in breadth and 35 ft. in height. The dock pumps will have a capacity to discharge 3,000 gallons of water per minute. It will take in the largest vessels in the Navy, and will be an important addition to the Yard.

PIG-IRON production is decreasing somewhat, as had been expected. The *American Manufacturer's* tables show that on May 1 there were in blast 262 furnaces, having a weekly capacity of 175,343 tons—a decrease from April 1 of 18 furnaces and 12,766 tons production. The greater part of this reduction—nearly 90 per cent.—was in the coke furnaces. There is, however, still a very large increase over last year, as on May 1, 1891, there were only 231 furnaces in blast, and their total capacity was 116,586 tons, showing a gain in weekly production this year of about 50 per cent.

Since January 1 the average weekly production of pig iron has been decreased over 8 per cent. It is still large, however, being at the rate of 9,000,000 tons a year. Stocks on hand are not increasing, and not much further decline in production is to be expected.

THERE is to be a convention held in St. Louis, June 2, for the purpose of advocating the speedy construction of the Nicaragua Canal under the control and direction of the United States. It is expected that delegates will be present to represent the commercial organizations of all the important cities of this country, and that some prominent men will take part in the proceedings.

THE success of nickel-steel in recent armor-plate trials has suggested the use of this alloy for guns, and it is understood that the Navy Department has ordered a set of forgings from the Bethlehem Iron Company for the purpose of making a cannon of nickel-steel, which will be subjected to a very thorough series of tests.

THE irrigation of a large extent of land, now uncultivated, in Upper Egypt is proposed by a French engineer. His plans include a series of dams on the Nile above Assouan, by which a chain of storage reservoirs can be formed, where the water will be held in reserve until the season when it is needed. These dams will not prevent the passage of the water required by Lower Egypt from the great river.

THE double-truck compound locomotives designed by Mr. T. W. Johnstone, Superintendent of Motive Power of the Mexican Central Railroad, are to be tried on that road, a contract to build three of them having been let by the Company to the Rhode Island Locomotive Works in Providence. These engines were recently described.

Mr. Johnstone is now making another careful comparative test of simple and compound locomotives on his road. It is to be thorough in its methods and interesting results are expected.

A VERY remarkable train was recently dispatched from Philadelphia to Chicago by the Baldwin Locomotive Works. The train consisted of 20 compound locomotives built for the Chicago & South Side Elevated Railroad; these engines are Forney locomotives of the Vauclain four-cylinder type, having cylinders 9 in. and 15 in. in diameter by 16 in. stroke, 42-in. driving-wheels and 26-in. truck wheels. They weigh 56,000 lbs. each, 40,000 lbs. being on the drivers, and were specially designed for this elevated railroad work.

The train was drawn by compound locomotive No. 82, with which experimental work has been done on several roads. This is a ten-wheel engine, also a compound of the Vauclain four-cylinder pattern; it has cylinders 14 in. and 24 in. in diameter and 24 in. stroke, and the six driving-wheels are 72 in. in diameter. This engine and its tender weigh about 200,000 lbs. in working order; the weight of the 20 small locomotives, without coal and water, was about 1,000,000 lbs., making the total weight of the train 600 tons.

The train was in charge of traveling engineers from the Baldwin Works, and relays of engineers and firemen were provided to run No. 82, so that it made the trip continuously, with only the necessary stops.

ENGLISH AND AMERICAN LOCOMOTIVES.

IN the London *Engineer* for April 22 the following letter on this subject was published, addressed to the Editor of that periodical :

SIR : I have to thank the Editor of the RAILROAD AND ENGINEERING JOURNAL, New York, for marked copies of his JOURNAL containing the articles on English and American locomotives, which you have since noticed editorially.

I am not at all desirous of entering into argument with either him or you on the general merits of the question. I may, however, say this much, that I believe it to be wholly a paper war between the editors of rival national engineering newspapers, and that there is not a pin to choose between either English or American engines, so far as the work either can do for a given quantity of fuel. Exactly the same may be said of other locomotives—French, German, or Italian. Whether as Englishmen we care to commit ourselves to all the fearful and wonderful gims and notions characterizing foreigners' engines is a totally different question.

I, however, wish to point out that in dealing with Indian railways in his January number, your contemporary has drawn wrong deductions from the figures quoted. I will point out where he has done so, not merely for the sake of putting him right, but just to show the worthlessness of his manipulating statistics in order to bolster up an argument on a matter of which he has no knowledge of details, to say nothing of using the figures wrongly.

Firstly, then, by making assumptions that were unnecessary, to allow for what he calls "switching" service, but what in English we call shunting and miscellaneous service, he makes out that the average yearly mileage of an engine in India is 23,265. If he will turn to statement No. 38 in "The Director-General of Railways Report for 1890–91," from which he quotes, he will there find the full service of engines given in "engine mileage," without any need for any assumptions for "switching" service. Taking out the total average, he will find it as follows :

$$\text{Standard gauge (5 ft. 6 in.)} = \frac{41{,}450{,}792 \text{ miles}}{2{,}370 \text{ engines}} = 17{,}500$$

engine-miles yearly.

$$\text{Meter gauge (3 ft. 3⅜ in.)} = \frac{16{,}951{,}602 \text{ miles}}{1{,}006 \text{ engines}} = 16{,}850$$

engine-miles yearly.

$$\text{Both gauges} = \frac{58{,}402{,}394 \text{ miles}}{3{,}376 \text{ engines}} = 17{,}300 \text{ engine-miles}$$

yearly.

So you see he was far too liberal. At the same time we are not at all ashamed of this mileage. We run our engines entirely on the "one-man-one-engine" principle, and therefore the above mileage represents what one engine with the same engineman can do. We all know, without being taught by Americans, that by keeping the engines running longer, by putting on double crews, or by working the engines in and out with the first men to hand, it is possible to get lots more work out of an engine. Except, however, in the case of a few lines, this system cannot be worked in India, or at the most only for a few months in the busy season. Even where possible to so work, the wear and tear and fuel consumption is very heavy. Enginemen do not take any pride in an engine that does not "belong" to them, and it gets knocked all to pieces. I have myself worked the double-crew system, and know all its advantages and disadvantages. About 10 years ago, being short of engine-power on a small meter gauge line in this country—India—I got an average of over 18,000 miles out of a batch of 14 goods engines in six months—that is, over 36,000 miles yearly out of meter gauge engines. That, I fancy, will be hard to beat, even in America. We earned 13 per cent. during that half year on the capital of the line. The work, however, for the men during the height of the hot weather was killing. Each engine had a double crew which traveled in a specially fitted carriage in the train, and the men went on and off duty just like engineers at sea, and they thus kept running for four days at a stretch till the engine needed a wash out. They then got one day at their home station. India is not America, and I should be sorry to try such an expedient in such a furnace of a country again. It was, however, the only way to tackle an abnormally heavy grain traffic that year, and the engineman who howled the loudest at the severity of the work was an American. I tried to comfort him with the reflection that we were for once working on Yankee principles, but he would not see it at all.

Secondly, your American contemporary says that Indian railways are not profitable to their owners, and proceeds to suggest that if equipped and worked with American rolling stock all this would be altered. Let him see Chap. I., paragraph 19, of the same report, whence he will learn that, taken all round, they earn a shade under 5 per cent. per annum. How is this for profit? Is the American average as high? Apparently he has got a bit mixed over the "loss to the State" due to fall of silver, by its having to pay interest in England on gold liabilities to certain guaranteed railway companies. In that case the "owners" in England really get more profit than is their proper due—for the depreciation of silver so called is really an appreciation of gold. Some of the companies earn as much as 7 per cent. to 9 per cent. Under these circumstances neither the State nor English shareholders are likely to make any radical changes in the way of rolling stock.

Thirdly, his assertions that the average consumption of coal is 41.67 lbs. per train mile, and that the average tonnage of a goods train was only 116.7 tons, are both incorrect. In the first place, he apparently gets these figures by striking an average of the averages of the several lines, which of course does not represent the average for the total mileage and tonnage at all. Such to be correct should be worked out from the totals direct. Further, he has mixed up railways of both broad and narrow-gauge, which of course renders his figures entirely illusory. He complains that he does not know if the "gross tons" include or exclude the weight of engines and tender. They of course include all dead weight, or otherwise they would be "net" tons, not "gross" tons.

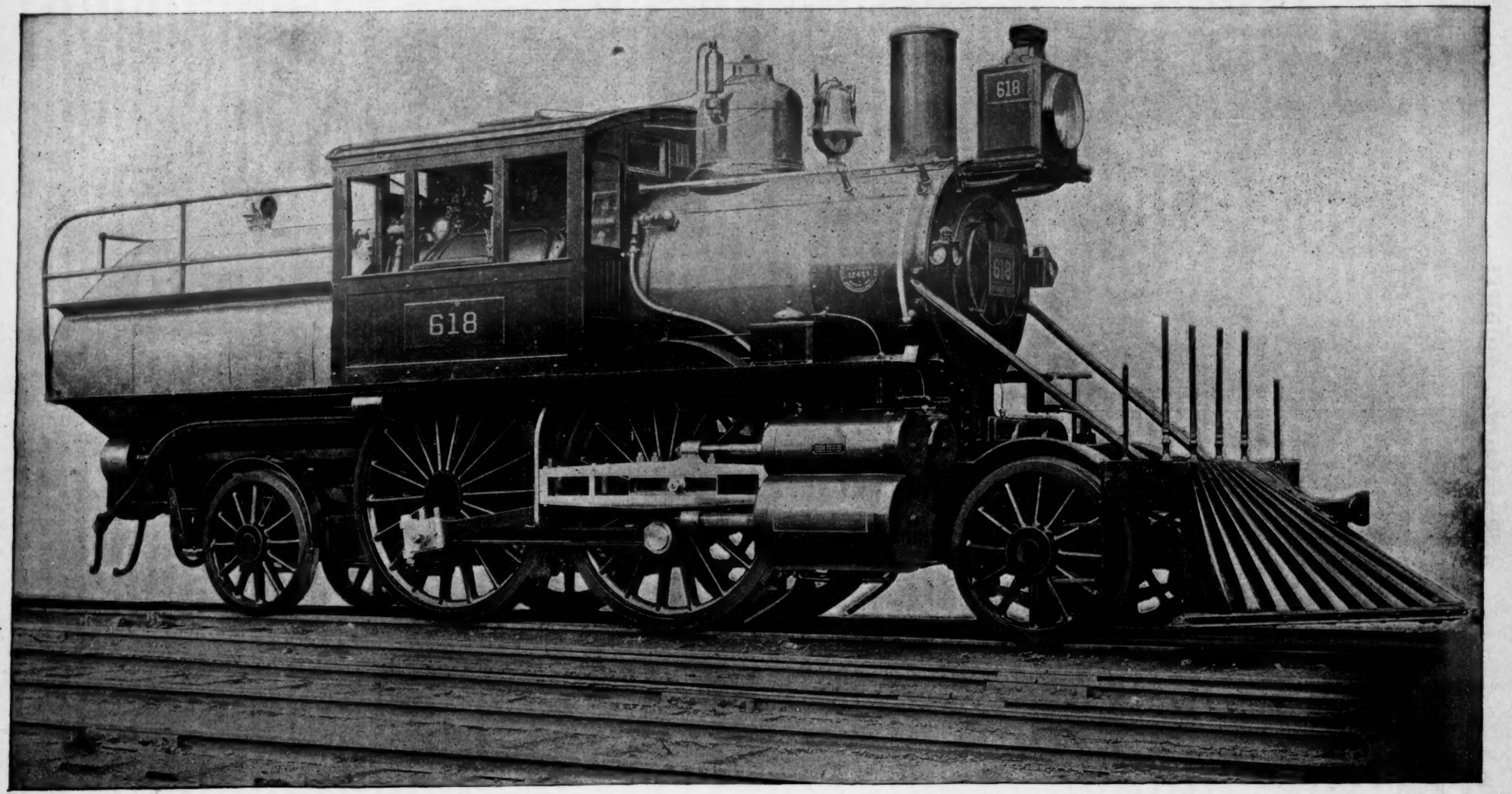
In conclusion, I beg to challenge his assertion that American locomotives, if put on Indian railways, "would run 50 per cent. more miles in a given time, and pull heavier loads." I have already shown that it is a question of men and human endurance—not of engines—that limits the performance of the latter. As, however, I suppose he has some American locomotive builders at his back, for whose benefit his articles have been written, I want to know where we can get one of these wonderful engines? If any builder will offer to supply one, and guarantee its performance, I will undertake to recommend the administration of my railway to purchase it, on the conditions being fulfilled within six months after landing here. The builders should send with it an American engineman of good tough constitution for a tropical climate, as it is clear that he will have all his work cut out for him. Communications may be addressed to me through you, sir. The general conditions are as follows : Maximum wheel load, 4 tons (English) on rail ; ditto height, 11 ft. ; ditto width, 8½ ft. ; ditto length, 35 ft. over all ; gauge, 3 ft. 3⅜ in. (1 meter). For obvious reasons I do not sign my name at present, but prefer to remain,

AN INDIAN LOCOMOTIVE SUPERINTENDENT.

To this letter the following answer has been sent, also addressed to the Editor of the *Engineer* :

SIR : In the *Engineer* of April 22 a correspondent, who signs himself "An Indian Locomotive Superintendent," challenges the assertion made in the RAILROAD AND ENGINEERING JOURNAL that American locomotives, if put on Indian railroads, "would run 50 per cent. more miles in a given time and pull heavier loads," and says that he supposes he—the Editor of the JOURNAL—"has some American locomotive builders at his back for whose benefit his articles have been written," and wants to know "where he can get one of these wonderful engines."

It is not entirely obvious what "having some locomotive builders at one's back" means. I may say, however, that the writer of the articles referred to has no interest whatever in any locomotive building establishment, excepting the little which results from the circumstance that some



VAUCLAIN COMPOUND FAST PASSENGER LOCOMOTIVE FOR THE PHILADELPHIA & READING RAILROAD.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS IN PHILADELPHIA.

of them advertise in his paper that they are prepared to do very excellent work. Furthermore, the articles referred to were not written with the knowledge, consent, or at the instigation or in the interest of any locomotive builders in this or any other country, excepting so far as the superiority of locomotives made either here or elsewhere was shown by the discussion.

Your correspondent gives the average mileage of locomotives on Indian railroads at 17,300 miles yearly. It was shown in the articles referred to—Table II, published last November—that the average annual mileage of nearly 15,000 locomotives in this country was 35,650 miles. Your correspondent inquires where he can get "one of these wonderful locomotives." In reply I will say that there are a half dozen or more reliable companies in this country who would furnish locomotives which they would guarantee to run an average of 36,000 miles per year under fair treatment and like conditions of traffic that prevail on our roads here; they would also guarantee that the engines would not be affected by the Indian climate, and that they could be run without disadvantage by different crews of competent men, so that the endurance of the men need not limit the number of miles run. Some or all of these builders would send competent men with the engines to see that they fulfilled the required guarantees.

If your correspondent will also furnish the requisite data concerning the grades, curves, speeds, or loads to be hauled, and quality of fuel and water used, the builders will also advise what type of locomotive should be used for the service, and would guarantee the loads they will haul, the speed at which they will run, and the amount of fuel they will consume, and would make the engines conform to the conditions given by your correspondent in his letter.

Furthermore, if he seriously contemplates, as he says he does, recommending the administration of his railroad to purchase an engine "on the conditions being fulfilled within six months after landing in India," I will take great pleasure in giving him any other information or advice in my power; and if he desires it, will ascertain the prices and conditions on which one or more locomotives can be furnished to his company, and will do this without any charge whatsoever to him, his company, or the builders of the locomotive.

M. N. FORNEY.

A FAST COMPOUND LOCOMOTIVE.

THE accompanying illustration is from a photograph of a compound locomotive recently built by the Baldwin Locomotive Works in Philadelphia for the Philadelphia & Reading Railroad. The general design will be seen from the engraving; the engine is carried on eight wheels, four coupled wheels placed close together under the boiler, a two-wheeled truck forward and a pair of bearing wheels under the fire-box. For fast work this makes a compact and easy running engine.

The work done by this engine has so far been very good. At the present time it is employed in running trains 503 and 512 of the Bound Brook Line between Jersey City and Philadelphia. On train 512 the distance of 85.1 miles between Wayne Junction and Jersey City is made in 98 minutes, or at an average speed of 52.1 miles per hour; there are no regular stops, but it is necessary to slow down at several junction and crossing points. On train 503 the time is not so fast, the 85.1 miles requiring 111 minutes, or an average of 46 miles an hour. On this trip, however, there are four regular stops, so that the time, making allowance for them, is, after all, nearly as good. This is done in regular daily work.

On May 13, the train drawn by this engine left Philadelphia 17 minutes late, owing to some delay between Baltimore and that city. Several stops are required before reaching Wayne Junction, but after passing that point the run was made at high speed. The entire distance—85.1 miles—from Wayne Junction to Jersey City was covered in 87 minutes, or at an average speed of 58.7 miles an hour. At one part of the run 10 miles were made in 7.55 minutes, or at the rate of 79.6 miles an hour. The train consisted of four heavy cars, and there was an adverse wind blowing.

The fire-box of this engine is of the Wootten pattern. The boiler barrel is 57⅛ in. in diameter, and contains 324 tubes 1¾ in. in diameter and 10 ft. long. The fire-box is 9 ft. 6 in. long and 8 ft. 0⅛ in. wide, the grate area being about 76 sq. ft. The heating surface is: Fire-box, 128.09 sq. ft.; combustion chamber, 45.37 sq. ft.; tubes, 1,261.75 sq. ft.; total, 1,435.21 sq. ft.

The engine is a compound, of the Vauclain four-cylinder type; the high-pressure cylinders are 13 in. and the low-pressure 22 in. in diameter, both being 24-in. stroke. The four driving-wheels are 6 ft. 6 in. in diameter, and the driving axles are only 6 ft. 10 in. between centers, making a very short parallel rod, an advantage at high speed. The driving wheel-base, as stated above, is 6 ft. 10 in.; the total wheel-base of the engine is 23 ft. 4 in.

The total weight of the engine in working order is 128,800 lbs., of which 82,800 lbs. are carried on the drivers.

The tender is carried on two four-wheeled trucks, and is of the usual pattern in use on the road. The tank has a capacity of 4,000 gallons of water.

NOTES FROM CHINA.

IN the January number of the JOURNAL the appointment of Mr. W. N. Pethick as Assistant Managing Director of the Imperial Railways of North China and the China Railway Company was noted. His authority has now been enlarged, and he has assumed joint control with the Managing Director of the financial business and accounts of those lines.

THE grading of the railroad from Tientsin to Shan-Hai-Kuan continues, and the rails were, at latest dates, expected to arrive from England soon.

THERE are rumors of the revival of the Viceroy Li Hung-Chang's original project of a railroad from Tientsin to Tung-chow, near Peking; but no definite announcement has yet been made.

JUST now the French are putting great pressure on the Chinese Government to force China to grant special privileges to France under Article 7 of the Franco-Chinese treaty of 1885. This article reads:

> When China on her part shall have decided to construct railroads, it is agreed that she shall have recourse to French industry, and the Government of the Republic shall afford every facility for procuring in France the staff that may be required. It is, moreover, understood that this clause shall not be looked upon as constituting an exclusive privilege in favor of France.

The Chinese originally allowed this clause to be inserted as an easy way of pleasing the French, but they never really meant anything by it. Recently, however, M. Lemaire, the French Minister at Peking, has formally complained to the Tsung-li Yamen—the Foreign Office—that China is not fulfilling the treaty. He maintains that the French accepted this concession in 1885 as an equivalent for a war indemnity, and threatens that, unless the Chinese favor France in the construction of railroads, the question of indemnity will be reopened. The Chinese Government has made a spirited reply, denying the claim made by France; but whether this resistance will be continued, or the Government will yield to pressure, is now doubtful.

THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.*

BY A. ZDZIARSKI, C.E.

THE WESTERN SIBERIAN RAILROAD.

IN my first article on the Great Siberian Railroad (in the JOURNAL for June, 1890, page 258) I expressed the opinion, that the Great Siberian Railroad would be con-

* See RAILROAD AND ENGINEERING JOURNAL for June, September, November and December, 1890; January, February, March and July, 1891.

structed as a continuous line connecting the European railroad system with the Amour settlements and the Pacific.

However, at that time this opinion had many adversaries, even in the Special Commission, appointed in order to fix the general location of the line; but now I am happy to state that my opinion has prevailed, for in February, 1891, the Committee of Ministers decided, and their decision was endorsed by the Emperor, that the surveys and location of the Western Siberian Railroad should be commenced from Chelabinsk, as a starting-point, and run to Tomsk or some other point of the Central Siberian Railroad already located. Chelabinsk is the terminus of the Zlatooust-Chelabinsk Railroad, now in construction, and described in the JOURNAL for November, 1890, page 503.

At the same time it was decided that the construction of the Great Siberian Railroad, already commenced at its eastern end on the Pacific Coast, should also begin from its western end, Chelabinsk, and on its western section, called the Western Siberian Railroad, which will be a continuation of the Samara-Oufa-Zlatooust Railroad, already opened, and of the Zlatooust-Chelabinsk line now in construction and to be opened in autumn, 1892.

Such decision was a consequence of the will of the Emperor, expressed in his rescript addressed to the Czarevitch, and made public on May 11/23, 1891, which stated that the Trans-Siberian Railroad shall be constructed as a continuous line.

According to the above the surveys of the Western Siberian Railroad should be so executed in the year 1891 as to furnish the definitive location, which shall be followed at once by construction. The cost of survey and location of about 1,000 miles was estimated to be 211,300 roubles, and the time required two years—1891 and 1892—for the location of the eastern section required more time, it being more difficult.

The surveys and location of the Western Siberian Railroad were so executed as to satisfy the following conditions:

1. That the main line be as short as possible and be designed with the smallest possible gradients and greatest radii of curves.

2. That it should go through the settled country and near the industrial centers or towns.

3. That the crossings of the rivers be convenient for navigation purposes and favorable for building of bridges.

4. That the construction of the railroad be as cheap as possible, which can be obtained by relaxing the specifications (technical conditions) in accordance with the requirements of locality and in view of a small traffic.

According to these conditions the line was *definitively* located from Chelabinsk to Kaïnsk (see the plan), 1,049 versts = 700 miles. The continuation of this line eastward could be made in two ways: One going directly to Tomsk with great technical difficulties, and the other going southward, through a less difficult country, to a connection with any point of the Central Siberian Railroad and including a branch to Tomsk. The choice of one of these lines will be made in this year (1892), but it is very probable that the southern line will prevail, as it is more economical in construction and more convenient for through traffic purposes.

The surveys of the year 1891 have given all the data necessary for the location and the estimates of the line from Chelabinsk to the Obi River, and for the approximate estimate of the remaining section of line from the Obi River to the junction with the Central Siberian line.

In the following paragraphs I give the results of the surveys made in the year 1891.

LOCATION AND LENGTH OF THE LINE.

The general location of the Western Siberan Railroad, from its starting-point—Chelabinsk—to the crossing of the River Obi, follows the parallel of the 55th degree of north latitude, with very small deviations, occasioned by the desire to draw near the towns, to meet more convenient places for crossing rivers or to avoid some obstacles. The greatest of these deviations bears only to a few minutes of latitude; the greatest northern deviation being 26′ (latitude being 55° 26′) for the crossing of the Obi River, and the greatest southern deviation 8′ (latitude being 54° 52′) near the city of Petropavlovsk. Straight lines, or tangents, dominate; there are 93.52 per cent. of straight lines and only 6 48 per cent. of curves. After crossing the Obi River the line deviates to the north and reaches its terminus on the Central Siberian Railroad in the latitude of 56° 9′.

The location of the line was not difficult, as is obvious from the following details. From the starting-point at Chelabinsk, the line follows an eastward direction, making some deviations in order to go round the lakes and marshes, till it reaches the River Tobol. After crossing this river near the city of Kourhan, the line rises over the divide between the Tobol and the Outiak, crosses the latter river and then follows an eastward direction up to the valley of the Ishim River. Having crossed this river near Petropavlovsk, the line rises over the divide between the Ishim and the Irtish, and then follows the almost level valley of the Kamishlov, an old tributary of the Irtish, now dry and presenting a series of bitter-salt lakes. After crossing this valley twice the line reaches the Irtish River, and crosses it 3 miles southward from the city of Omsk, at a point most convenient for a bridge or ferry.

After crossing the Irtish River the line enters the Baraba Steppe (plateau), such a level country that it was possible to locate there two straight lines or tangents, one 60 miles long and another 86 miles long. The first of these straight lines goes along the Omi River, a tributary of the Irtish, and the other is controlled by the general direction of the line to the city of Kaïnsk and the numerous lakes, which it meets before it reaches that city.

From Kaïnsk eastward the line still follows the valley of the Omi River, and then the divide between that river and the Chany Lake. After crossing this divide near the source of the Tandovka River, the line follows the southern slope of the divide, crosses the Kojourla River, goes along the Great and Small Karapouz rivers, then follows the divide between the Karapouz and the Kargat rivers, enters the most level part of the Baraba Steppe, touches the south limit of the Vasugan Tundra, and reaches the station of Chulim, 1,220 versts = 813 miles from Chelabinsk.

To this point the location is accepted as final.

From the Chulim station the further location will depend upon the point selected for the crossing of the Obi River.

This point of crossing the Obi will very probably be fixed near the village of Krivoshchekova (southward of Kolivan), and the corresponding location of the line directed northeastward, after crossing the divide between the rivers Obi and Tomi and the River Tomi near Taly, and being led through very difficult mountain country following the divide between the Kitat and Yaya rivers, will reach the station Pochitanka of the already located Central Siberian Railroad, 80 miles from Tomsk.

The main line, located as above, will be connected with the city of Tomsk by means of a branch line 79 versts = 52 miles long, which could be constructed with relaxed technical conditions.

The mathematical distance between Chelabinsk and the Obi River at Krivoshchekova is 1,290.57 versts, the length of the line 1,324 41 versts; the difference is 33 84 versts, or 2.8 per cent. only.

The total length of the located Western Siberian Railroad, from Chelabinsk to Pochitanka, a station of the Central Siberian Railroad, is 1,620 07 versts = 1,080 miles.

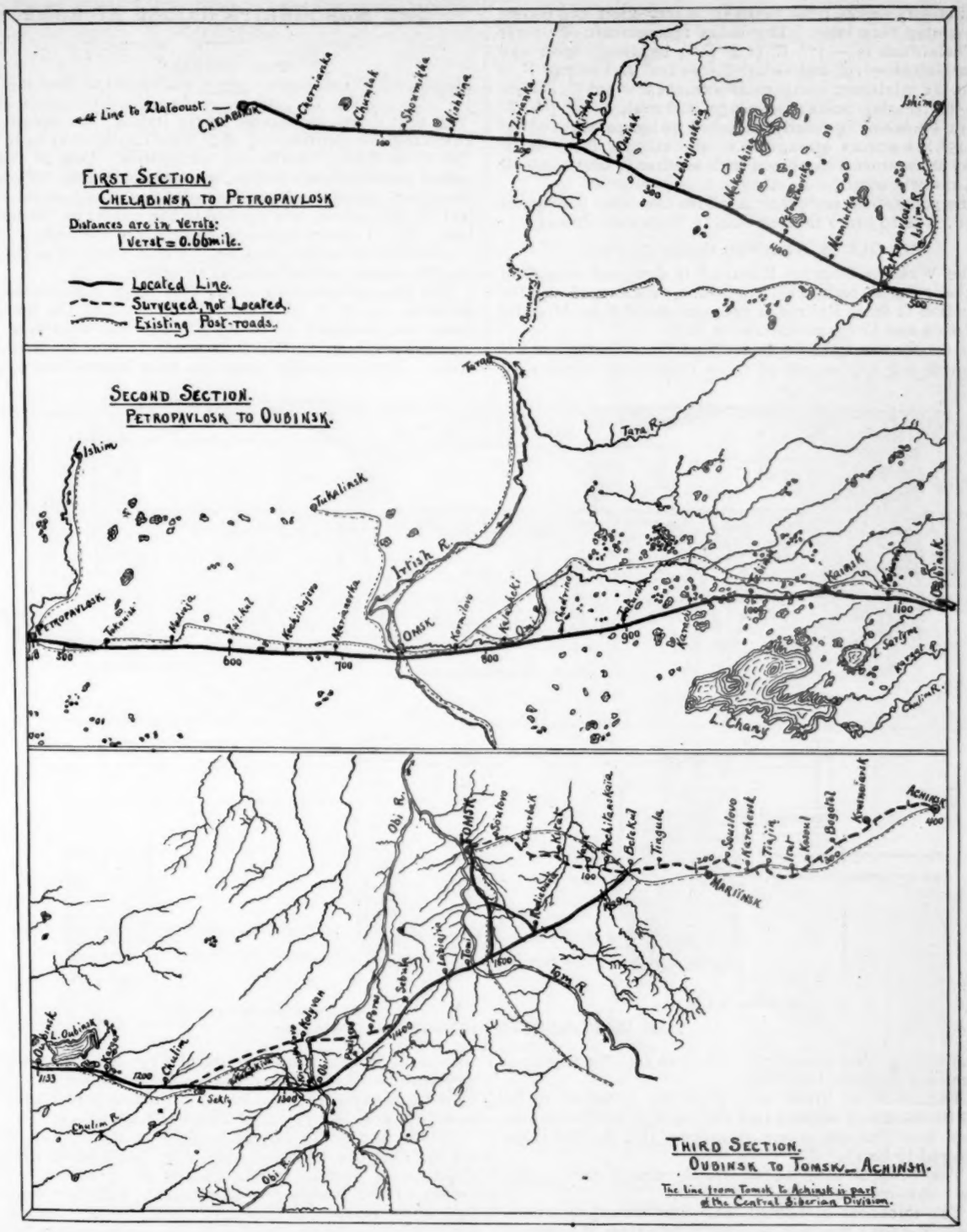
TOPOGRAPHY, CLIMATE AND POPULATION.

In consequence of the varying character of the country the above located line must be divided into two divisions, as follows:

I. From Chelabinsk to the Obi River 1,324 versts = 883 miles.

II. From the Obi River to Pochitanka 296 versts = 197 miles.

The first section (from Chelabinsk to the Obi River) is a level plateau cut by three great rivers: the Tobol, the Ishim and the Irtish. The ground is so level as to be almost ready for track-laying; only the crossing of the great rivers will require heavy earthworks. The soil is



LOCATION OF THE WESTERN SIBERIAN RAILROAD.

generally fertile; the climate is favorable for agriculture, which could be largely developed.

According to the quality of the soil and the quantity and quality of water, this division can be subdivided into three sections:

1. From Chelabinsk to the Ishim River, where the soil is fertile and consists of vegetable earth with clay subsoil, there are many lakes and small birch woods, and the production of crops is great.

2. Between the Ishim and the Irtish rivers, where the soil is partly salt marsh, partly fertile; the lakes have bitter-salt water, good water occurs seldom, and the chief occupation of the inhabitants is the breeding of cattle.

3. Between the Irtish and the Obi rivers, where the country is covered with a quantity of salt and sweet lakes, marshes and birch woods, and the soil presents good clay earth and partly salt earth.

The second division, from the Obi to Pochitanka, is a mountain country covered with untouched forests (taïga), with abundant springs and small rivers; here the location was very difficult.

The climate along the line of the Western Siberian Rail-

road is very severe; the summer is very short and warm, the winter very long. The mean temperature of winter in Chelabinsk is — 17° C. (1.4° F.); between Omsk and Lake Baïkal — 19° and — 22° C. (— 2.2° and — 7.6° F.); often the minimum temperature reaches — 40° C. (— 40° F.), the freezing point of mercury, and even — 50° (— 58° F.) in Tomsk. The daily variation of temperature of 25° C. (45° F.) occurs often, and in the steppes there occur heavy snow-storms combined with southerly, southeasterly and easterly winds.

The population is very thin, about two men per square verst; it is 10 times thinner than in European Russia.

DETAILS OF DESIGNED CONSTRUCTION.

The Western Siberian Railroad is designed according to the relaxed technical conditions, elaborated by the Direction of State Railroads and endorsed by the Minister of Roads and Communications in 1887.

Of course the light topography of the country has not required the application of these relaxations concerning the limiting gradients and curvatures, so that the principal relaxations were the following:

1. The width of grade was generally admitted to be 16.45 ft., except in marshy soil and on high embankments subject to shrinkage, where it will be 18.2 ft.; the slope is allowed to be 1½.

2. The bridges may be of wood, except over great rivers; cast-iron culverts are allowed.

3. The thickness of ballast was fixed at 12½ in. under the foot of rails; the rails of a very light type, the weight being 54 lbs. Russian (49 lbs. English) to the yard.

4. The line buildings will not be numerous and will be of very simple type; the road crossings are allowed to be unprotected.

5. The distance between stations (sidings) was allowed to be 50 versts = 33 miles; the passenger buildings of very simple description, according to local conditions of traffic, and freight sheds only required in great industrial centers.

6. The distance between water supplies was allowed to be the same—33 miles—and the water supply to be made by means of the pulsometer.

7. The rolling stock supplied will be sufficient for two trains (a mixed and a freight train) daily in each direction.

(TO BE CONTINUED.)

THE MARGHERITA BRIDGE AT ROME.

(From *Industries.*)

In 1881 a law was passed by the Italian Government for enforcing the construction of at least two bridges over the Tiber, at Rome, by the city authorities. One of these, called the Garibaldi Bridge, was completed in 1888, and the other, called the Margherita Bridge, which is the subject of this article, was opened to the public in December last. Fig. 1 shows a general elevation of the bridge; fig. 2 a transverse section, and fig. 3 a half plan. The bridge is a handsome and substantial structure.

The foundations were made with large compressed air caissons, 100 ft. × 46 ft. 6 in. The depth of the foundations was intended to be 43 ft., but was afterward increased to about 52 ft. below the low-water level of the river. The foundation work has been carried out by the Société of Fives-Lille at a cost of $399,500. The superstructural work, including the piers and arches, has been done by Messrs. Allegri, Lazzeri & Company, of Florence, in a little over two years, at a cost of $232,300.

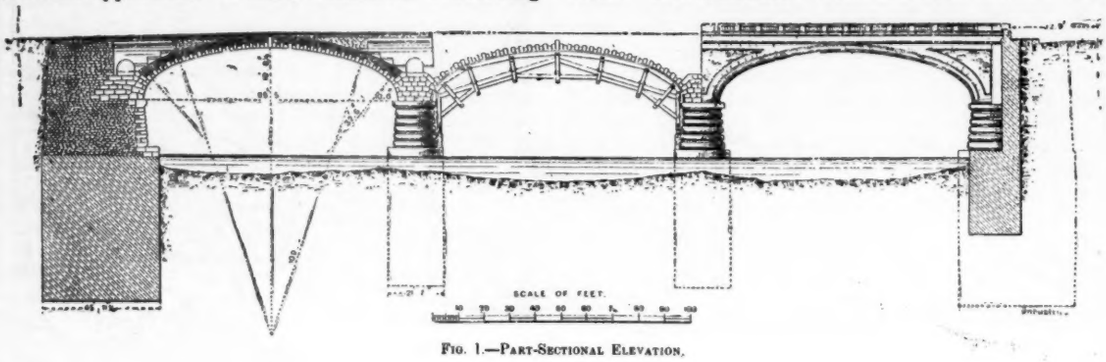


FIG. 1.—PART-SECTIONAL ELEVATION.

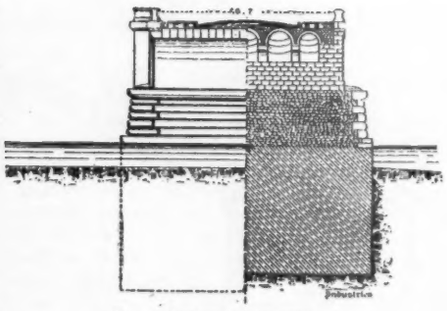


FIG. 2.—TRANSVERSE SECTION.

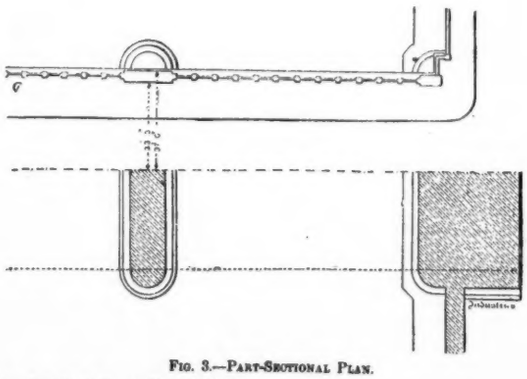


FIG. 3.—PART-SECTIONAL PLAN.

THE MARGHERITA BRIDGE AT ROME.

This is one of the largest bridges in Rome, and there are few that can compete with it for boldness of design, elegance of outline, and accuracy of execution. The arches of the bridge are polycentral, with five centers, their shape being approximately a half ellipse. Each arch is of 99 ft. chord and about 16 ft. 6 in. pitch, with a height from the foundation of 75 ft. 4 in. The tops of the piers on which the arches are based are about 17 ft. 9 in. above the upper surface of the foundations and 21 ft. above low-water. The roadway is about 370 ft. long by 67 ft. 6 in. wide at the narrowest point.

The strength of the principal materials used in this bridge is as follows: Stone of Rezzato, 1,500 kilos. per square centimeter; Travertino, 900 kilos.; bricks, 180 kilos.; cement, 38 kilos. The tests were made with Michaelis' machine, and the figures given above represent an average of 950 tests made.

This bridge, along with the Garibaldi Bridge, was designed by Signor Angelo Vescovali, Chief Engineer to the hydraulic service of the city of Rome, who has also designed two for the suburbs.

AN EARLY DESIGN FOR A COMPOUND LOCOMOTIVE.

To a long and carefully written report on the Compound Locomotive, made by the Committee on Science and the Arts to the Franklin Institute of Philadelphia, and published in the *Journal* of the Institute, we are indebted for the accompanying engravings, which show an early design for a compound locomotive. It is not stated, however, that a locomotive was ever built from these plans, although a stationary engine was apparently built by the inventor. The designs were given in a book called "The Chemistry of the Steam Engine," by Thomas Craddock, published in London in 1847. His engine was a condensing engine, in which air instead of water was used in the condenser. The report says:

In the month of April and year 1844, Mr. Craddock made experiments with a compound engine of his own designing, which he says is "the *first* engine ever constructed on the principles I am here treating of, which are those of condensing by *air* with the production of a *vacuum*."

The extent of the vacuum obtained by these means—a revolving fan-wheel—was 18 in.

"On the application of the invention under discussion to locomotive engines, I have thought much, as we had at one time determined on constructing a locomotive upon the principles I have set forth. . . .

"The best mode, as it appears to me, of applying these principles for locomotive purposes, would be to construct a tubular boiler, having several ranges of tubes. . . . I should also propose that, to insure the most economical use of the steam, the *twin cylinders*, of which I have before spoken, be fixed much in the same way as the cylinders are at present. We should then have a combination of the high- and low-pressure engine moving itself and a train along our railway. . . . Another thing to be desired, which would result from such locomotives as I am here speaking of (with air condensation and return of condensed steam to the boiler again) is, that we should have no noise from, or even *appearance* of steam."

Mr. Craddock further states that, with his twin engine

Fig. 1.

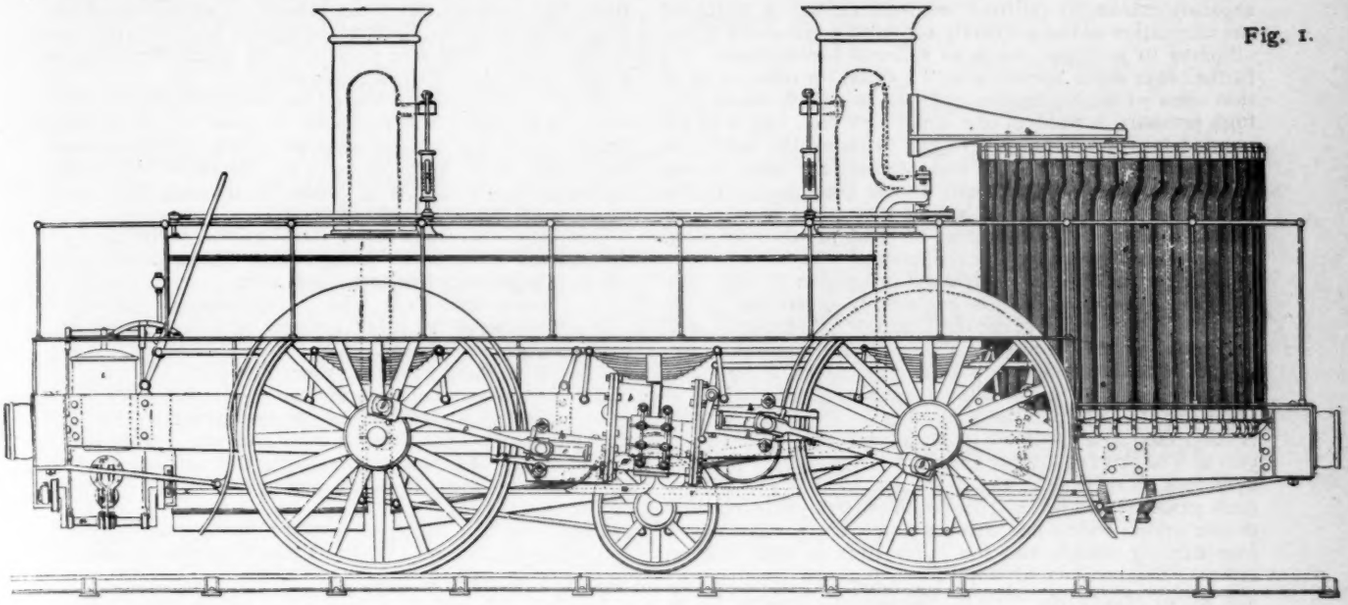
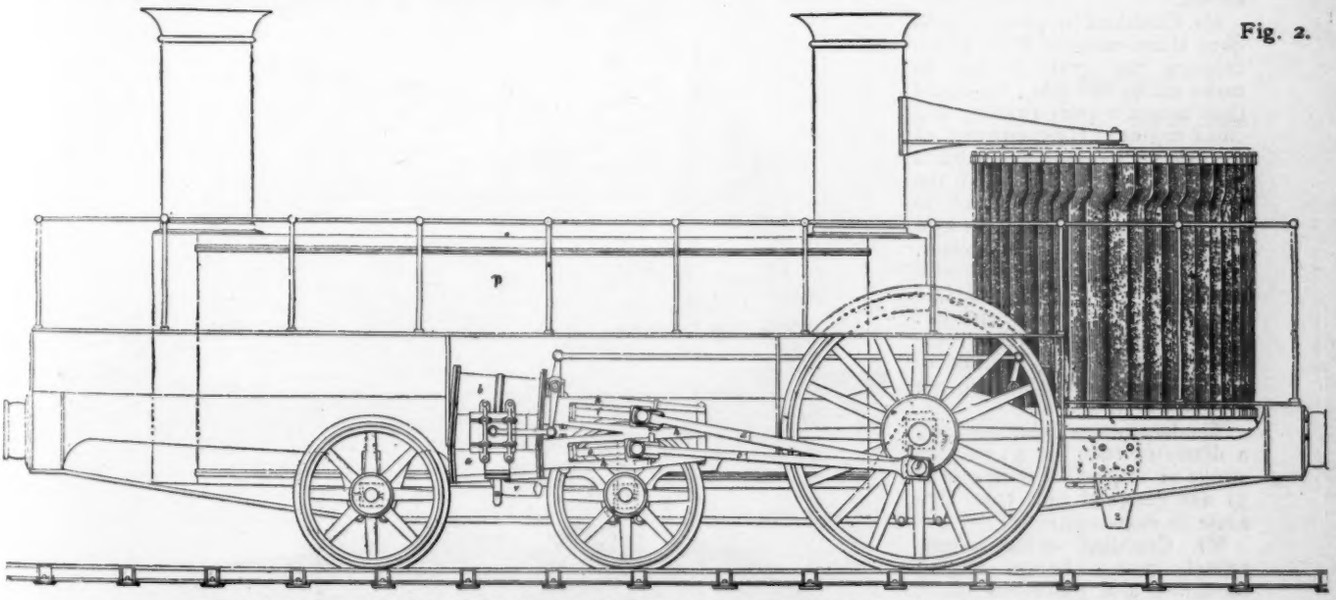


Fig. 2.



DESIGNS FOR A COMPOUND LOCOMOTIVE, BY THOMAS CRADDOCK, IN 1847.

of 6-in. and 14-in. cylinders combined with his air condenser, by which he obtained a 24-in. vacuum, thus realizing his anticipations, he also performed a double quantity of work with the same quantity of steam. "I have fixed upon 115 lbs. as the pressure of steam in the boiler, because that is the pressure I have used. But many years will not pass before 200 lbs. pressure per square inch will be used, and this with almost total exemption from danger."

Mr. Craddock's patent universal condensing steam engine bears date December 3, 1846, and embodies a claim for the adaptation of double-cylinder engines, attached to separate cranks, to railroad locomotives, and a claim for the adaptation of the angularly-set double-cylinder engine, attached to a single crank, to railroad locomotives. He further says more specifically, "I claim, in relation to all that class of high-pressure engines in which steam of a high pressure is used in one small cylinder, and then expanded into a second and larger cylinder, the setting of the cylinders at an angle and connecting them to one crank-pin, whether combined or not combined with my other improvements, all or any of them, and in whatever position the said cylinders may be fixed in other respects, as horizontally, vertically or obliquely."

Mr. Craddock's book, published in London in 1847, giving full descriptions of his engines, is illustrated by 10 large folding plates of general and detailed views, well and handsomely executed. Three of these plates represent railroad locomotives, with two cylinders, a high- and a low-pressure on each side of each engine. In one of them (fig. 1), with parallel-located cylinders, each cylinder is connected to a crank of its own—two to a forward and two to a backward driving axle; in the other (fig. 2), both cylinders on each side, angularly set, so that the axis of each passes through the center of the driving axle, connect to one crank and to one driving axle; the former having four driving wheels and the latter two, no side rods on either. Illustrations of both these types of construction are given herewith, which sufficiently explain themselves.

Mr. Craddock proposed to produce steam without blast by increasing the grate surface to make up for this loss; he would thus secure a quiet running and clean engine. He condensed all the exhaust steam in an enclosed air fan-wheel, returning all the water of condensation back to the boiler for reconversion into steam. He used tubular boilers, which afford thin metal, with large extent of surface, supplied pure water to the boiler, and thus avoided deposit, condensed the steam, thus availing himself of the benefit of expansion at the *best* end of it.

The locomotive cylinders have a diameter ratio of 4 : 10 with stroke of 12; driver diameter of 52 and gauge of rails 55½. (No scale on drawings.)

Mr. Craddock certainly conceived many happy engine thoughts, and published much data having creditable simplicity, well worth our study. His theories and principles of construction are well marked with many lines of perfection, and considering date and conditions, his eight years and more of daily experimentation, fraught as they are with results, deserve well of our praise.

This design of Mr. Craddock's is earlier than that of John Nicholson (1850) or of James Samuel, which is of the same date. Mr. Samuel referred to the continuous expansion or compound system for locomotives in a paper published in 1852, which has been frequently quoted.

THE UNITED STATES NAVY.

IT is probable that the battle-ship *Texas* will be launched at the Norfolk Navy Yard on July 4. Work on the *Texas* is now well advanced, and the ship is nearly ready, being in fact much further forward than the *Maine* when she was launched.

LAUNCH OF THE PRACTICE CRUISER.

The practice cruiser *Bancroft* was successfully launched from the yard of the S. L. Moore & Sons Company, at Elizabeth, N. J., on April 30, being the first war-ship built in that yard. The *Bancroft* is to be especially attached to the Naval Academy at Annapolis.

Peculiar difficulties attended the designing of this ship, which is intended to have, as far as possible, all the main features of a modern war-ship on a very limited displacement, and to be supplied with all the varied appliances necessary to give the naval cadets full training in the management of the latest type of vessels.

The vessel is a twin-screw steel cruiser, with the chief dimensions as follows: Length between perpendiculars, 180 ft.; length on water-line, 187 ft. 6 in.; extreme breadth, 32 ft.; mean draft, 11 ft. 6 in.; displacement, 838 tons.

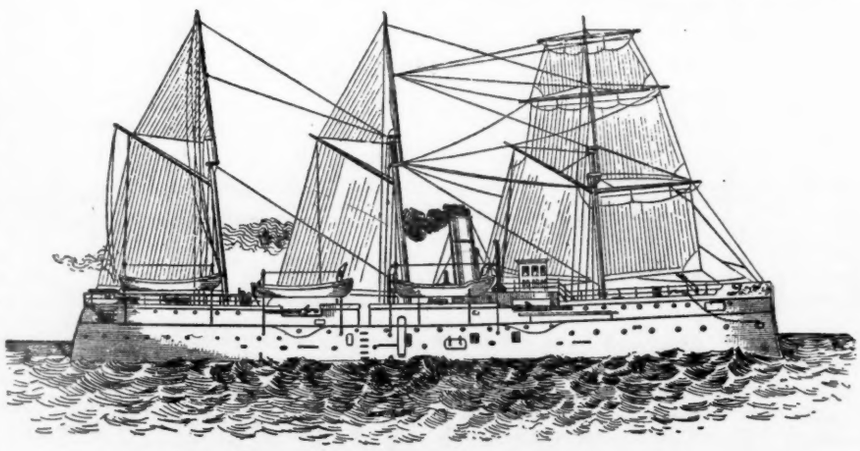
Unlike some of the other cruisers, she is provided with considerable sail power. The rig is that of barkentine, the sail area being about 5,000 sq. ft.

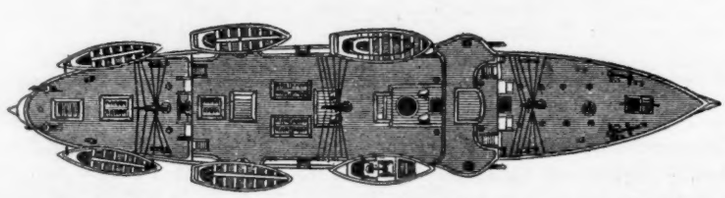
The armament consists of four 4-in. rapid-fire rifled guns, mounted on central pivots and protected by steel shields; three 6-pdr., two 3-pdr., and one 1-pdr. rapid-fire cannon; one 37-mm. revolving cannon, one Gatling gun, and two torpedo-tubes, one above water, and one bow launching tube.

There will be a full electric plant, steam-steering gear, and other appliances. Quarters are provided for captain eight officers and 120 cadets and seamen.

The engines, one for each screw, are of the direct-acting, vertical, inverted, triple-expansion type, with cylinders 13½ in., 21 in. and 31 in. in diameter and 20 in. stroke. There are two boilers, each 8 ft. 8 in. in diameter and 17 ft. long, with two corrugated furnaces 39 in. in diameter.

The coal capacity is 140 tons on normal draft. With this supply the radius of action is 1,560 knots at 13 knots an hour; 2,400 knots at 10 knots an hour, or 3,850 knots at 8 knots an hour.





PRACTICE CRUISER "BANCROFT," UNITED STATES NAVY.

LAUNCH OF THE "CASTINE."

THE gunboat *Castine* was launched from the yard of the Bath Iron Works, Bath, Me., May 11. She is a sister ship to the *Machias*, built at the same place, which was described in the JOURNAL for January. For convenience it may be repeated here that she is an unarmored steel ship 190 ft. long, 32 ft. beam, 12 ft. mean draft and 1,050 tons displacement. She has twin screws, each driven by a triple-expansion engine, with cylinders 15 in., 25 in. and 34 in. in diameter and 24 in. stroke. The speed is expected to be 14 knots, and the cruising range at a 10-knot speed about 4,700 knots.

The *Castine* will carry eight 4-in. rapid-fire guns and a secondary battery of four 6-pdr. and two 1-pdr. rapid-fire and two Gatling guns. She will have two masts, with fore-and-aft rig, and a considerable spread of canvas.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS.

XXVII.—SAMPLING; AND THE ENFORCEMENT OF SPECIFICATIONS.—(*Concluded.*)

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(Copyright, 1889, by C. B. Dudley and F. N. Pease.)

(*Continued from page* 211.)

IN making our test reports we use a blank, copy of which is given below. It will be observed that this blank gives the date, specifies the shop for which the material is to be furnished, describes the material, states when it was received, who from, on what requisition number, and at what price. This information is furnished by the tag which accompanies the sample from the shop. It will also be observed that there is a space left on the blank to give the analysis. It has been our custom many years to give the figures of the analysis. We do this for two reasons. First, as a means of instructions to those who use the reports, since universal experience seems to show that the more a man knows about the materials he is dealing with, the more efficient he will be. Second, in case of dispute the manufacturers have a right to know the results of our tests, and, as will be explained a little farther on, the test report ultimately goes to the Purchasing Agent, and by him can be shown, if necessary, to the manufacturer whose material is condemned. It will be observed that there are two blanks, both bearing the same number and differing in the wording at the bottom of the blank. In one case, where the material is ready for use, this sentence is printed in, and it is necessary only to sign the name at the bottom. In the other case, where the material does not fill specifications, the blank is left open so that the recommendation to return, and the reasons why, can be written in in ink. On the back of the blank is given the proper nomenclature for the record and also a synopsis of the specifications. This synopsis is given so that in case of dispute, it will not be necessary to get out the specifications, but simply turn the test report over and see what the essential points of the specifications are. This information is for the use of the Purchasing Agent and those with whom he is brought in contact over rejected materials. The following are the blanks:

M. P. 233.

PENNSYLVANIA RAILROAD COMPANY.

MOTIVE POWER DEPARTMENT.

REPORT OF TESTS.

Altoona, Pa.,.....18....

At *Shops, Sample of*

received *from*

on requisition *at*

test as follows:

This is according to specifications, and material is ready for use.

....*Chemist.*

M. P. 233.

PENNSYLVANIA RAILROAD COMPANY.

MOTIVE POWER DEPARTMENT.

REPORT OF TESTS.

Altoona, Pa.,.....18....

At *Shops, Sample of*

received *from*

on requisition *at*

test as follows:

.....*Chemist.*

(BACK OF BLANK.)

No.....

Material,..... .....

Received, ...

From..... .....

Order No.....

Form "C," No.....

Passed.....

SYNOPSIS OF SPECIFICATIONS.

Blue Vitriol.—Not over ¼ per cent. crystalized sulphate of iron, nor more than ½ per cent. of all other impurities. Contain nothing that will go through $\frac{3}{16}$ in. mesh sieve, and will not go through 1¼ in. mesh sieve.

Cabin Car Color.—Always purchased dry. No adulterant. Not less than 57 per cent. or more than 60 per cent. normal lead chromate. Not less than 38 per cent. or more than 42 per cent. lead oxide. Must not vary from standard shade.

Caustic Soda, or Concentrated Lye.—Bought by the pound, in half-pound or pound boxes, and in drums or barrels. Solid or granulated as ordered. Sample represents shipment, and only caustic soda (NaOH) paid for. Material must contain not less than 90 per cent. NaOH.

* These articles contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July and August numbers, on How to Design a Paint; No. XX, in the September number, on Disinfectants; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative; No. XXIII, in the November and December numbers, on Soap; No. XXIV, in the January, 1892, number, on Steel for Springs; No. XXV, in the February number, on Bearing Metals; No. XXVI., in the April number, on How to Make Specifications.

Detergent for Cleaning Paint and Varnish.—Mixture of powdered soap and tripoli or pumice; the tripoli or pumice not less than 65 per cent., or more than 75 per cent.; not more than 0.10 per cent. carbonate soda; 0.20 per cent. caustic soda; 0.30 per cent. common salt, or 5.00 per cent. water. No other substances than soap and tripoli or pulverized pumice. Must not scratch varnish.

Disinfectant.—Not less than eight fluid ounces per bottle, and not less than 20 per cent. zinc, 1 per cent. copper, 23 per cent. chlorine, and 0 14 per cent. mercury by weight. Shipments in barrels must show not less than 15.8 per cent. zinc, 0.8 per cent. copper, 0.13 per cent. mercury, and 18 per cent. chlorine.

Freight Car Color.—Bought in paste form, and paste must contain nothing but oil, pigment, and moisture, must not have over 2 per cent. volatile matter, and must not be a liver when received. Oil must be pure raw linseed, and must not be less than 23 per cent. or more than 27 per cent. of the paste. Pigment must have sulphate of lime fully hydrated, must contain no barytes, organic coloring matters, caustic substances, not less than 2 per cent. nor more than 5 per cent. carbonate of lime, not less than 40 per cent. sesquioxide of iron, and no inert material less opaque than sulphate of lime. Must conform to standard shade, and must pass test for fine grinding.

Locomotive Spring Steel.—Must be free from physical defects. Must not vary more than .01 in. in thickness, and 0.02 in. in width from size ordered. Not less than 0.90 per cent., or more than 1.10 per cent. carbon; not more than 0.50 per cent. manganese, 0.05 per cent. phosphorus, 0.25 per cent. silicon, 0.05 per cent. sulphur, 0.05 per cent. copper.

Mineral Wool.—Samples from three bags to be tested. Average weight of three samples not over 15 lbs. per cubic foot.

Oil—Extra Lard.—No other oils; not more free acid than is neutralized by 4 c. c. standard alkali, and must pass nitrate of silver test. From October 1 to May 1, cold test not over 45° F.

Oil—Extra No. 1 Lard.—No other oils; not more free acid than is neutralized by 30 c. c. standard alkali. From October 1 to May 1, cold test not over 45° F.

Oil—Neatsfoot.—No other oils; not over 15 per cent. free acid. From November 1 to April 1, cold test not over 45° F.

Oil—Tallow.—No other oils; not over 15 per cent. free acid. From November 1 to April 1, cold test not over 45°.

Oil—150° Burning.—Must not flash below 130°, nor burn below 151°. Color, "water white." No glue or suspended matter. Must not show cloud at 0° Fahrenheit for 10 minutes.

Oil—300° Burning.—Must not flash below 249°, nor burn below 298°. Color, "water white." No glue or suspended matter. Must not show cloud at 32° Fahrenheit for 10 minutes.

Oil—Paraffine.—Gravity, 24° to 29° Baume. Flash not below 249° Fahrenheit. Red or amber in color. Viscosity not less than 40 or more than 65 seconds. Cold test not above 10° Fahrenheit from October 1 to May 1.

Oil—Well.—Gravity, about 29° Baume. May 1 to October 1, flash not below 249°. October 1 to May 1, flash not below 200°. Cold test not above 10° F. from October 1 to May 1. No precipitation with gasoline. Viscosity not less than 55 or more than 100 seconds.

Oil 500°.—Straight petroleum; flash not below 445° Fahrenheit. No precipitation with gasoline.

Phosphor-Bronze Bearing Metal.—Bought in lots of 20,000 lbs. Inspected and weighed at place of manufacture. Mixed borings from three half pigs must show not less than 9 per cent. or over 11 per cent. of tin, not less than 8 per cent. or over 11 per cent. lead, not less than 0.70 per cent. or over 1 per cent. phosphorus, and all other substances than copper, tin, lead, and phosphorus in no greater amount than 0.50 per cent.

Sal Ammoniac.—Must be granulated or in pieces not larger than a wheat kernel. Not less than 65.15 per cent. of chlorine. Not less than 31.20 per cent. of ammonia (NH_3).

Soap—Common.—Bought by weight. Bars about one (1) lb. Not over $\frac{1}{4}$ per cent. caustic soda, $\frac{1}{4}$ per cent. carbonate soda, $\frac{1}{4}$ per cent. mineral matter, and 1 per cent. common salt. 525 grains soda (N a 2 O)= one (1) lb. soap. Cylinder of soap $\frac{7}{8}$ in. diameter and 1 in. long must hold up 5 lbs. five minutes, with not over $\frac{1}{16}$ in. compression.

Soap—Toilet.—Bought by weight. Cakes about $\frac{1}{4}$ lb. Not over $\frac{1}{4}$ per cent. caustic soda, $\frac{1}{4}$ per cent. carbonate soda, $\frac{1}{4}$ per cent. mineral matter, 1 per cent. common salt. 630 grains soda (N a 2 O) = one (1) lb. soap. Glycerine and sugar paid for. 5 grains glycerine or 20 grains sugar equal 1 grain soda. Cylinder of soap $\frac{1}{4}$ in. diameter, 1 in. long must sustain 15 lbs. five minutes without crushing or compressing more than $\frac{1}{16}$ in.

Springs—Helical.—Not less than 0.90 per cent. carbon, and not over 0.50 per cent. manganese.

Tallow.—Free from dirt or cracklings. Not more free acid than is neutralized by three (3) cubic centimeters, standard alkali. No soap or other foreign substance.

Tuscan Red.—Bought in paste form, and paste must contain nothing but pigment, oil, turpentine, and moisture. Paste must show not less than 74 per cent. of pigment, nor less than 8 per cent. of oil, and not more than 5 per cent. of moisture, or more oil than one-seventh of the weight of the pigment. Oil must be pure raw linseed oil, and turpentine of good quality. Pigment must contain not less than 75 per cent. sesquioxide of iron, not less than 2 per cent. or more than 5 per cent. carbonate of lime, and no barytes, or caustic substances, or organic coloring matter that has not been approved. Must conform to standard shade and pass test for fine grinding.

Wood Preservative.—Product of the distillation of Georgia pine. Must not flash below 172° Fahrenheit, burn not below 200° Fahrenheit, have a gravity less than 1.03, have more than 12.00 per cent. tar, or less than 30.00 per cent. tar acids. Must run freely at 20° Fahrenheit.

Zinc or Spelter.—Not more than $\frac{1}{4}$ per cent. lead, nor more than $\frac{1}{10}$ per cent. of any other substance except zinc.

In case material fills all the requirements of the specifications, there is nothing requisite except for the officer who receives the bill to pin the test report to the bill, to sign the bill, and forward it in the regular way for payment, sending word at the same time to the shops that the material may be used. No bill for materials for which we have specifications is paid without the test report attached, and this portion of the service is very efficient, so far as we are able to determine. If the material does not fill the specifications, the test report says so, recommends the return, and tells why. This test report goes through the offices to the officer who has the bill, he immediately pins the test report to the bill, and returns the bill which goes in the regular way to the Purchasing Agent with a request to arrange for the return. Word is also sent to the shop ordering the material not to be used, but to be held subject to orders. In process of time the material is sent back to the party from whom it was purchased, with the usual requirement that he pay the return freight. It is customary for the manufacturers to be allowed a second opportunity to fill the requirements of the specifications on the same order. It sometimes happens, however, that the order is cancelled and placed with other parties.

It is always an objection to have to return a shipment, as it disarranges the work of the shops, and many times makes it necessary to supply that shop with material from some other portion of the road until the material can be replaced. This has led the Purchasing Agent to keep a record of those who fail to fill the specifications, and if the general habit of any manufacturer is to fail he soon loses all orders. From our own standpoint the temptation always is to accept a shipment rather than to reject, and if there is any bending or wavering or yielding in the specifications, it is always in favor of the manufacturers, as from the reasons already given we do not like to reject shipments unless we are compelled to.

A very interesting feature of our experience in the matter of rejected shipments has been, that if some peculiarities of the specifications are ignored, and material accepted which does not quite fill the requirements, the manufacturers soon learn to take advantage of this, and every shipment that comes has this peculiarity. There is nothing so good to make shipments come up to specifications as an occasional rejection, and the more rigid the rejection the better the shipments which follow.

It will, of course, be understood that emergencies in the service may arise of such a nature that it would be absolutely essential to use inferior materials that do not fill specifications, and it would also naturally be understood, at least by those who are conversant with railroad affairs, that the Laboratory would not be a good judge of these emergencies, since it does not know at all the shops how much material is on hand. Accordingly each Superintendent of Motive Power is armed with a discretionary power to use a shipment of material, even though it does not fill the specifications, provided the emergency demands it. From his position he knows the condition in which each of the shops are as to supplies, and as the movement of trains depends on the supplies, notably so in the matter of oils, he must either use a condemned shipment sometimes, or else supply the shop from some other place. As the result of this discretionary power it sometimes happens that condemned materials which do not fill specifications

are used, and some manufacturers have deceived themselves into thinking our specifications were not enforced, knowing that inferior materials had been sent and that they had not been returned. It is not at all certain that the Railroad Company does not know that the materials are inferior and do not fill specifications because they are not returned. Emergencies are constantly arising which make it requisite to use inferior materials. The remedy comes, however, a little later in the loss of orders from the Purchasing Agent, as has been above described, since the Purchasing Agent is informed from month to month, in a report duly made for the purpose, of all materials that fail to fill specifications. It is fair to say that in general these emergencies which call for the use of condemned materials are few in number, and that by far the largest number of the condemned shipments are duly returned and replaced with good materials.

It is more than probable that the query will arise, at least among those who are conversant with the uncertainties of chemical methods, as to how these uncertainties are provided for in our methods. For example, it is well known that ordinary testing machines are not accurate to possibly within 500 lbs., or, again, it is well known that certain chemical methods do not give accurate results to within a small fraction of one per cent. The question arises, therefore, who shall have the benefit of this doubt, due to the uncertainties of the method? If a shipment of phosphor-bronze shows 11.10 per cent. of tin, this would be above the limit of our specifications, but the method of determining the tin may have not given accurate results to the extent of 0.10 per cent., and, as stated above, the query arises, whether the Company shall take this uncertainty or whether the manufacturer must meet this uncertainty? This question is not quite satisfactorily settled yet. We are inclined to think that the limits of our specifications are so wide, that if a manufacturer knows what he is doing, and aims between the extremes of our limits, he will never have a rejection due to getting outside the limits, even though the uncertainty of the method is construed against him. On the other hand, our experience now for many years has shown that very few manufacturers, especially outside the steel trade, know well what they are doing. Few of them have chemists and most of them work by rule of thumb, and many of them make the mistake of aiming at the limit which will just pass, so that it not infrequently happens we have been compelled to take the uncertainty of the analysis upon ourselves or else reject shipments. We are inclined to think it is immaterial which way the thing is adjusted, as if the manufacturer assumes the uncertainty of the method we would make a little broader limits in our specifications than if we have to assume the uncertainty of the method ourselves. In either case the limits are wide enough, we think, if any manufacturer understands his business, and one of the peculiar results of our specifications has been, that the trade of the Pennsylvania Railroad Company has necessarily drifted into the hands of those parties who are best informed in their own business, since they give us less trouble in the filling of specifications.

Several methods have been proposed to overcome the difficulty of having to return shipments which do not fill specifications. It is well recognized that many of the limits of our specifications are commercial, and that it would be impossible to detect in the service whether the material exactly filled specifications or came a little short. Of course, on the one hand, the efficiency of the specifications, and the certainty of getting good material in the future, depends on their enforcement. On the other hand, as has already been explained, the temptation constantly is to accept and use inferior materials, owing to the annoyance that arises from their return. It requires usually not less than a couple of weeks to get a rejected shipment replaced, and this, in addition to the extra work thrown upon all the offices by returning materials, has produced a natural disposition not to return rejected shipments. Among the propositions made to obviate this difficulty was to announce to the manufacturers, that three shipments of rejected material would debar them from all orders for a year, thus making the continuance of their business depend on the quality of the material furnished. This method, it is believed, will be extremely difficult to enforce. Another method was to make it a part of the contract, when the order is placed, that if the material failed to fill specifications, and the Company decided to use it, owing to an emergency, they should be at liberty to do so at a deduction of one-third or one-half from the bill. Of these three methods—namely, return the material that does not fill specifications, decline to give orders if the material does not fill specifications, and use material at a diminution from the price, the latter seems possibly the most feasible and the fairest all around. The first is at present in force, the last is being discussed, with the idea of substituting it in part for the first—that is, materials which we decide to use due to an emergency will be paid for at a diminished rate. Nothing positive has yet been decided on this question, however.

It is, of course, fair that if the shipment of material is rejected, the manufacturer should question our analysis, and it is also fair that he should have a part of the sample which we worked on to submit to other chemists, if he desires to do so. We have accordingly adopted a plan of retaining the samples from all rejected shipments for two weeks. A portion of this retained sample is at the disposal of any manufacturer who feels aggrieved at our decision. He can have a portion of this sample and send it to any chemist that he chooses. Of course if there is a difference between the other chemist and ourselves we try to get together, and by interview, or by working on similar samples, or by referring the matter to a third party straighten the matter out. In general we have been very fortunate in not being upset in our tests. We have had a number of severe contests, both with manufacturers and with their chemists, but it is very rare that our results have been set aside. It is simple wisdom on the part of any man rejecting material that he should have a good fighting margin before he recommends the return of the shipment. If no question is raised within two weeks we throw the sample away and regard the transaction as ended.

TRANSPORTATION BY WATER.

THE Census Bureau has recently issued Bulletin No. 179, giving the statistics of Transportation by Water in the United States. The figures collected by the Census cover the year 1889, and have been arranged and prepared by Mr. Thomas J. Vivian, under the general direction of Pro-

NUMBER, REGISTERED TONNAGE, AND ESTIMATED VALUE OF ALL VESSELS ENGAGED IN FREIGHT TRANSPORTATION, REGISTERED IN UNITED STATES PORTS.

GEOGRAPHICAL DIVISIONS.	TOTAL.			STEAM VESSELS.			SAILING VESSELS.			UNRIGGED.		
	Number.	Long Tons.	Value.	Number.	Long Tons.	Value.	Number.	Long Tons.	Value.	Number.	Long Tons.	Value.
Atlantic Coast	12,453	2,794,440	$123,874,177	2,713	793,571	$70,503,090	6,490	1,383,108	$45,545,357	3,250	617,761	$7,735,730
Gulf of Mexico	1,008	77 562	3,851,270	220	45,591	2,961,450	613	17,249	788,110	175	14,722	101,710
Pacific Coast	1,842	441,939	23,067,370	531	170,503	15,826,455	822	208,080	6,715,570	489	63,356	825,345
Great Lakes	2,784	926,355	48,941,474	1,480	599,949	41,193,324	987	187,006	4,275,650	308	139,400	3,472,500
Mississippi Valley	7,453	3,393,380	15,335,005	1,114	210,772	10,539,251	....	.....	.....	6,339	3,182,608	4,795,754
Total	25,540	7,633,676	$215,069,296	6,067	1,820,386	$140,813,570	8,912	1,795,443	$57,324,687	10,561	4,017,847	$16,931,039

fessor Henry C. Adams. The Bulletin serves to show the great importance of water transportation to the country.

The total number, registered tonnage, and estimated value of all vessels engaged in the transportation of freight on December 31, 1889, are shown in the accompanying table.

The total tonnage carried during the year 1889 by these vessels is given as follows :

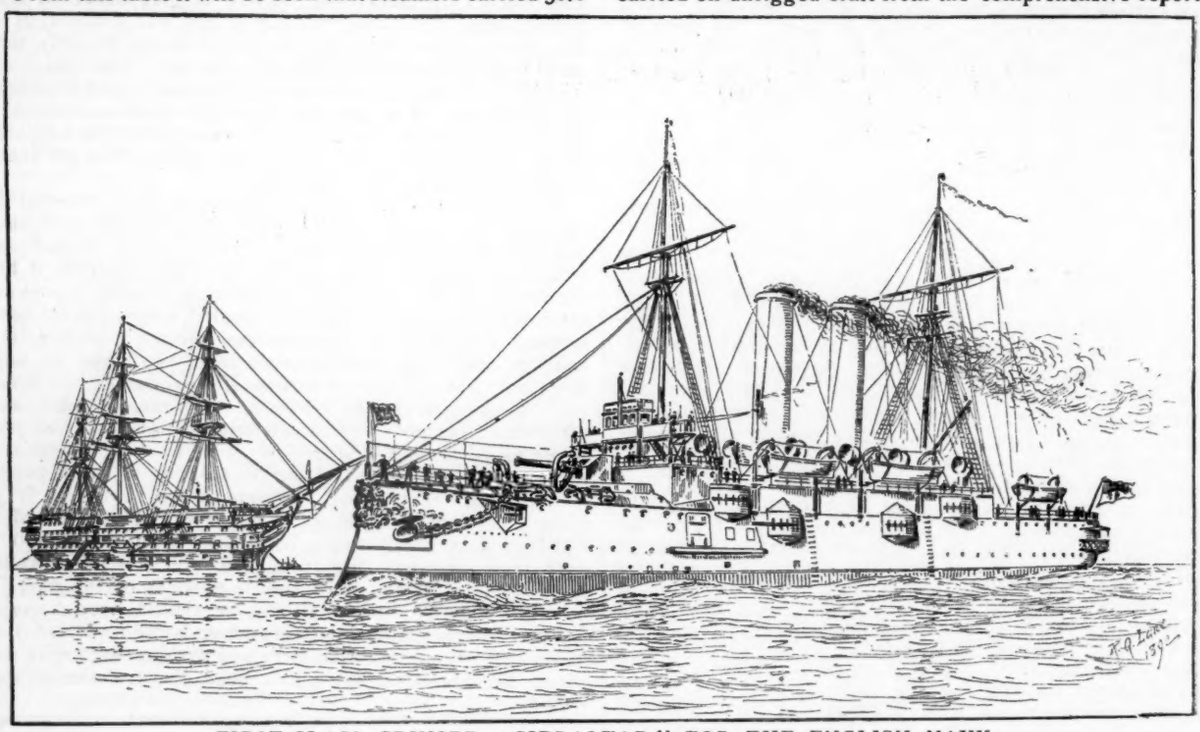
[Geographical Divisions.	Total all Craft.	By Steamers.	By Sailing Vessels.	On Unrigged Craft
Atlantic Coast.....	77,597,626	28,778,341	38,283,401	10,535,884
Gulf of Mexico.....	2,864,956	1,455,450	1,359,526	49,980
Pacific Coast.....	8,818,363	5,741,940	2,761,826	314,597
Great Lakes.....	53,424,432	20,181,483	19,302,949	13,940,000
Mississippi Valley.....	29,405,046	10,345,504	.....	19,059,542
Total.	172,110,423	66,502,718	61,707,702	43,900,003

From this table it will be seen that steamers carried 38.6 per cent. of the total tonnage ; sailing vessels, 35.9, and unrigged craft, 25.5 per cent. Arranging the freight tonnage by geographical divisions, we find 45 per cent. of the total credited to the Atlantic Coast, 2 to the Gulf of Mexico, 5 to the Pacific Coast, 31 to the Great Lakes, and 17 per cent. to the Mississippi Valley.

The Bulletin reports that in 1889 there were 106,436 persons employed on these craft, and that the wages paid them amounted to $36,867,305, being an average of $347 each. By far the largest number was on the Atlantic Coast, where 54,859 persons were reported—an average of 4.41 to each vessel. On the Gulf of Mexico there were 3,891, or 3.76 per vessel ; on the Pacific Coast, 15,809, or 8.58 per vessel ; on the Great Lakes, 15,881, or 5.60 per vessel ; and in the Mississippi Valley, 15,996, or 2.15 per vessel. Some of these averages seem unwarrantably low.

These statements do not include fishing vessels—a fleet of nearly 7,000 craft. These were not regarded as properly engaged in transportation, and will be the subject of a separate report.

With regard to the unrigged craft the Bulletin says : "Since 1881 the registration of barges and such other craft as have no motive power of their own has not been insisted on except in the infrequent case of those occupied in the carriage of bonded goods. The registration of barges, etc., having therefore largely become a matter of convenience and option, the records of the custom house contain but a very small proportion of the unrigged craft belonging to American owners, and the records of the census have been entirely made up from lists compiled from its own inquiries. An idea of the difference between the account of registered and unregistered barges may be gained from the statement that according to the statistics of the Commissioner of Navigation there were 1,185 registered barges to be found in all the customs districts of the United States, while, as the census table in question shows, there were 10,561 of such barges in operation in 1889, and even the excess of 9,376 by no means covers the existing number of craft of this description. The tonnage of these 10,561 barges was the exceedingly large one of 4,017,847, while the importance of this contingent to the American mercantile fleet is shown by its value, which has been estimated at no less than $16,931,039. The record of the freight carried by the unrigged craft was not an easy matter to secure, and it was found a particularly difficult task to separate the accounts of freight actually carried on unrigged craft from the comprehensive reports of the steamers furnishing the motive power by which transportation was effected. The figures in this third table therefore cannot be accepted as absolutely full, but at the same time the 43,900,003 tons given as the amount of freight moved on these unrigged craft must not be considered as an estimate, but as an actual account for so far as the investigation has gone."



FIRST-CLASS CRUISER "GIBRALTAR," FOR THE ENGLISH NAVY.

The tables show that there is still a large number of sailing vessels employed in the coasting traffic and on the lakes. In the Mississippi Valley the number of barges and other craft having no motive power and depending on towing is very large.

It may be added that, taking the totals, the average registered tonnage per steamer was 300 tons ; per sailing vessel, 202 tons ; and for each of the unrigged craft, 380 tons. The highest average tonnage per vessel, including all classes, was in the Mississippi Valley, where it was 455 tons ; the craft on the Great Lakes come second, with an average of 333 tons ; those of Pacific Coast third, with 240 tons ; the Atlantic Coast fourth, with 224 tons ; the Gulf of Mexico last, with only 77 tons. This is a somewhat unexpected result, but is probably accounted for by the number of small schooners and similar craft employed on the Atlantic in the coasting trade.

A NEW FIRST-CLASS CRUISER.

(From the London *Engineer*.)

THE accompanying sketch shows the first-class cruiser *Gibraltar*, which has just been launched from the Napier yard at Govan, Scotland. She is shown in Belfast Harbor, because a previous *Gibraltar*, one of the old line-of-battle ships, lies there, and has been introduced into the picture for the sake of contrast.

The new *Gibraltar* is a steel twin-screw cruiser of 7,700 tons displacement, having triple-expansion engines of 12,000 H.P. constructed by the Napiers, the builders of the hull. She is 360 ft. long and 60 ft. beam, and will draw a little over 24 ft. of water.

There are six double ended boilers, with 48 furnaces. The engines have cylinders 45 in., 59 in. and 88 in. in diameter and 51-in. stroke. With 5,500 H.P. it is expected that she will have a speed of 16 knots; with 10,000 H.P., 18½ knots, and at 12,000 H.P., with forced draft, 19½ knots. The coal capacity is 850 tons and the cruising radius at slow speed is 10,000 knots.

The armament of the *Gibraltar* will consist of one 9.2-in. 22-ton gun; ten 6-in. 5½-ton rapid-fire guns, five in each broadside, six being on the upper deck and four in sponsons on the main deck. The secondary battery will include twelve 6-pdr. and three 3-pdr. rapid-fire guns, eight machine guns and two boat guns. There will be also four 14-in. torpedo-tubes.

The protective deck is of steel, with a maximum thickness of 5 in. and a minimum of 2 in. Above and below its slopes are coal bunkers. As the engines rise somewhat above this deck, the upper parts are protected by 5-in. inclined plates backed with teak. The conning-tower is of 12-in. plates; the larger guns are protected by steel shields. In addition to numerous water-tight compartments, the ship has a double bottom amidships.

The total estimated cost of the ship is $1,657,500, of which $916,500 will be for hull, masts and rigging, $487,500 for machinery, and the balance for armament, etc. She has two light masts.

The present *Gibraltar* is the eighth of the name in the Navy; the seventh—shown in the engraving—is now known as the *Grampian*. She is a wooden screw ship, built at Devonport in 1860, and is used as a training ship for boys at Belfast. She was finished just about the time when wooden walls began to give place to ironclads. She was twice in commission, but only for short periods, and has been a training ship for a long time.

THE LATEST DISCOVERY IN ELECTRICITY.

(W. E. C. Gordon in the *Nineteenth Century*.)

ON Wednesday, February 3, the Royal Institution in London was crowded with one of the most critical scientific audiences in the world, who were held spellbound for more than two hours while Mr. Tesla gave an account of his discoveries. Mr. Tesla is a young electrician born at Rieka, on the border of Montenegro, and now domiciled in America. The interest of the lecture lay not in the beautiful experiments with which it was illustrated, nor in the actual facts put forward, but in the hope which it held out that we may now draw back a little farther the veil which hides one of the most fascinating mysteries of nature—namely, the relations between light and electricity, and between matter and motion.

The tendency of modern science is to remove day by day the barriers between its branches. Our views of the phenomena of light and heat, of electricity and magnetism and even of matter and motion, are rapidly merging into one general theory of molecular physics, which is perhaps best expressed by the vortex theory of Sir William Thomson.

According to this theory, the whole of every part of space is filled with a fluid called ether, almost infinitely elastic. The historic experiments of Faraday, interpreted by the mathematical researches of Clerk Maxwell, have demonstrated almost beyond doubt that the same ether whose waves carry light and heat from the sun and stars to the earth also carries the waves of electric and magnetic induction which, as the daily experiments at Kew Observatory show, follow each outburst of solar activity.

Sir William Thomson holds that all that which we know as matter consists of vortices or whirlpools of this ether, which, from their rapid rotating motion, resist displacement, and therefore show the common properties of hardness and strength in the same way as a spinning top or gyroscope tends to keep its axis in a fixed direction. But whether the molecules or particles of what we know as matter are independent matter, or whether they are ether whirlpools, we know that they keep up an incessant hammering one on another and thus on everything in space.

Professor Crookes has shown that the forces contained in this bombardment are immensely greater than any forces we have yet handled, many millions of horse-power being contained in an ordinary room. Owing, however, to the forces being in every possible direction they neutralize each other, and no result of them is perceivable to our senses; but if ever we discover how to so direct their courses as to send the majority of them in the same direction, we shall have at our disposal forces as much exceeding any we are now acquainted with as the blow struck by a bullet exceeds the force required to pull the trigger of a gun. In fact, as Mr. Tesla put it in his lecture, "We shall then hook our machinery on to the machinery of nature." It is because they hold out to us a hope, however distant, of some day so guiding the ether storm, that the experiments of Nikola Tesla are of such transcendent interest and importance.

Professor Crookes, in his experiments on "radiant matter," has given us the first hint of a method of directing what, for want of more exact knowledge, we will call the molecules of matter. With the appliances at his command, however, he was unable to impart any great change of direction, but he succeeded in making that change manifest by reducing the disturbing forces acting against his directing force. In other words, he pumped out from glass bulbs and tubes nearly all the air or other gas that they contained, and the comparatively few particles left were then free to travel in any course imparted to them without much change caused by collision with others. This special direction was imparted by means of electricity, and gave us the beautiful phenomena of phosphorescence and radiant matter, which are now so well known in these experiments.

By means of suitably shaped terminals a stream of molecules is focussed on a given point. If a piece of carbon or platinum is placed at that point, it becomes white hot under the bombardment from identically the same cause which causes a sheet of flame to appear when a cannon shot strikes an iron target. If a ruby or other phosphorescent material is placed there, it glows with its characteristic color, and if a little delicately balanced vane or windmill is placed on one side of its fans it rapidly revolves. The forces available in these experiments were, however, almost indefinitely small, being, as it were, merely flying spray from the great torrent into which we have not yet been able to penetrate.

We now come to the advances made by Mr. Tesla.

In all the above experiments the electricity by which the directing force was imparted to the molecules was electricity of a comparatively slow alternation period—namely, electric currents oscillating about 80 to 100 times per second. It was as if we had tried to ventilate a room by causing a man to walk slowly through it with an umbrella. He would undoubtedly move the air, but would move it so slowly that ordinary methods would be insufficient to enable us to perceive its motion. In order to cause a rush of air we must put a rapidly moving fan or other suitable machinery. Mr. Tesla seeing this, abandoned the ordinary dynamo, which, as we have already noted, gives about 80 alternations per second, and the ordinary induction coil, which gives about the same number, and boldly constructed a dynamo which gives 20,000 alternations per second, and by connecting this to suitable condensers he multiplied its alternations until they reached 1,000,000 or 1,500,000 per second.

Then at once an entire set of new phenomena appeared, and the experimenter entered a region of mystery and hope. One of the first things noticed was, that either because these vibrations are too rapid to excite corresponding vibrations in the nerves of the body or from some other cause, no shock is felt from the current; and that though an ordinary current at 2,000 volts will kill, yet this current at 50,000 volts cannot be felt at all.

It was also found that the vibrations keep time in some unknown way with the vibrations of solid matter. Vulcanite is one of the best insulators known, and will entirely stop any ordinary current or discharge; but the stream of sparks between two poles with this current pours through a thick sheet of vulcanite as easily or even with greater ease than through air. It does not perforate it in any way, but passes through it as light passes through glass.

All the "Crookes" phenomena of radiant matter are almost indefinitely increased; it is the blow of mitrailleuse bullets compared to the blow of an air-ball thrown against the wind. The forces can be directed for a considerable distance through space without the aid of wires. Electric lamps light easily when attached to one single wire, and require no return conductor; and, more wonderful still, if metal plates are fixed on the roof and walls of a room and connected to the terminals, the whole atmosphere of that room, whether it be ether or whether it be particles of common matter, is thrown into a state of storm and agitation which can be at once made perceptible by bringing into the space tubes or globes from which the air has been partially exhausted. Such tubes, though without any metallic connections, yet glow and throb as if powerful currents of electricity were being sent through them from an ordinary induction coil.

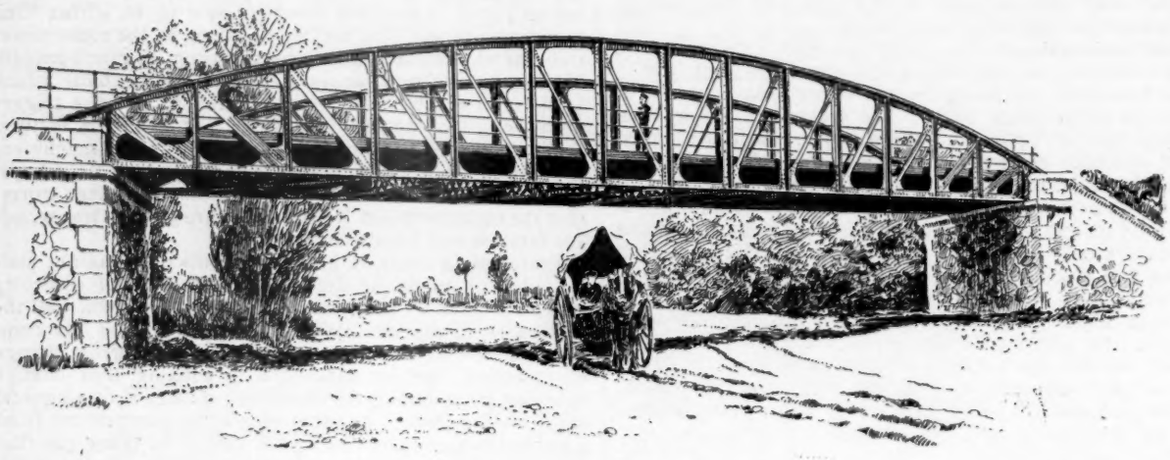
A Crookes radiometer placed near a metal conductor from which neither spark nor glow is perceptible, yet rotates as if it were placed near a lamp or heated body, but rotates in the wrong direction, and, last of all, a true flame burns in which nothing is consumed.

When the discharge issues from a suitable terminal it has the appearance and roaring sound of a gas flame burning under too high a pressure, and gives off a considerable heat; to use Mr. Tesla's words again: "This is not unexpected, as all the force and heat in the universe is due to the falling together of lifted weights, and the same result is produced whether these weights have been lifted apart by chemical energy, and rest in the form of oxygen and hydrogen ready to combine chemically, or in the form of mechanical energy of moving molecules directed by the electric current."

On the same table on which Mr. Tesla's experiments were shown a few days ago there swung in the year 1834 a delicately balanced galvanometer needle, under the influence of the first induction current, produced by the genius of Faraday. The force available to move it was very small, probably not greater than the forces lighting Mr. Tesla's tubes, yet that force has now developed one of the great industries of the world. It lights millions of lamps in London and elsewhere; in America it drives cars on thousands of miles of railroad, and will soon distribute the power of Niagara Falls to the inhabitants of the neighboring States. May we not hope for such development of the new discovery, and that we shall some day harness to our machinery the natural forces, which from the beginning of time have literally been slipping through our fingers?

Should the application of Mr. Tesla's results ever fulfil the bold dreams of scientific imagination, we shall see a social and political change at least as important as that caused by the railway system or the electric telegraph.

Most manual labor will become unnecessary, as unlimited power will be available at every man's hand. Engineering works can be carried out on a far greater scale than has yet been contemplated, and doubtless a corresponding era of material prosperity will set in; but whether these dreams are ever fulfilled or not, few who attended Mr. Tesla's lecture will forget the possibilities which seemed to open to their minds when they saw a living man standing in the midst of the electric storm, receiving unharmed in his hands flashes of veritable lightning, and waving above his head a tube, through which the very life-blood of creation pulsed, in waves of purple fire.



A SPANISH RAILROAD BRIDGE.

SOME SPANISH RAILROAD NOTES.

FROM AN OCCASIONAL CORRESPONDENT.

GREAT progress has been made all over Spain in recent years in bridge building. The question often occurs to the traveler, What is the need for such long and handsome bridges? Where is the water? The truth is, that for nine or ten months of the year, in most cases, there is no water, and the river-bed is used for cart traffic, forming generally a better road than the ill-kept highways. Suddenly, during the wet season, along come the rain and melted snow from the mountains, filling the dry bed and often overflowing; sometimes in such volume as to sweep away heavy abutments and piers of masonry.

The first illustration given—taken in the dry season—shows a bridge over the Vilamajor River, on the railroad from Llinás to San Celoni. The river-bed is shown entirely dry and used as a road. This bridge is a riveted arch truss of 29 meters (95 ft.) span, on masonry abutments; it was built by the Sociedad Material para Ferrocarriles y Construcciones, of Barcelona.

The second illustration is of historic interest; it shows a very ancient masonry bridge near the town of Martorelli in the province of Barcelona, crossing the Noya River. This bridge is known as "El Puente del Diabolo"—the Devil's Bridge—the tradition being that his Satanic Maj-

esty was concerned in its building, and still occasionally shows himself under the archway at the center. This archway—a shelter and toll-house combined—is peculiar, and no similar construction is known to exist elsewhere in Spain. It is remarkable, by the way, how much the Devil has been, according to old-world tradition, mixed up in the bridge-building business; there is hardly a country in Europe that has not its "Devil's Bridge." In the more civilized New World, of course, our bridge-builders are as far removed as possible from any connection with Satanic or underground influences.

In this illustration, it may be noted that the bridge seen in the distance, through the arches of the old bridge, is the longest railroad bridge in Spain.

SPANISH CAR BUILDING.

There are at present three shops for the construction of railroad cars in Spain, and these are apparently enough for the demand. Two of them are in or near Barcelona, the commercial capital. The most important is that of the Maquinistá Terrestre y Maritimá, where locomotives also are built; the shops of that company are at Barceloneta. The second in rank, which your correspondent visited, is that of the Sociedad Material para Ferrocarriles y Construcciones, which has its offices in Barcelona and its works at the little town of Pueblo-Nuevo, near by.

It may be noted here that it is no easy matter to get information in Spain, as all the companies, both railroad and industrial, seem to fear comment and criticism. In all cases special permission must be obtained to visit or inspect shops, and this is not always readily granted.

The Sociedad above named has at its head a rich and aged proprietor, Sr. Manuel Girona. It employs about 500 men, and 150 of these are in the car shops. The passenger car shop—*fabricá des coches*—is a large and well-built shop; it is lighted by arc lights, as are all the buildings; the dynamos are made by the Sociedad Anglo-Española de Electricidad.

Of the 150 men in the shop over 50 are carpenters, and they have their benches in a long row, numbered in regular order. They work from 6 A.M. to 6 P.M., with an hour and a half off for meals; wages vary from 3 to 5¾ pesetas (58 cents to $1.10) per day. Saturday is pay-day, and the Spanish workman is not at his best on Monday, although the difference is not nearly so marked as in England, for instance.

Quick work is not usual. The time required for building a passenger coach is usually from 3 to 3½ months. Two months is the best time recorded; but in Spain nobody is in a hurry. The wheels, of wrought iron as elsewhere in Europe, are imported from France, Belgium, Germany or England; the rest of the work is of native manufacture, including upholstery and all the smaller fittings. Oil lamps are universally used; gas has never been introduced, and electricity is most likely to replace oil, should a change be made.

At the time the shops were visited there were 12 first, second and third-class coaches under way. One of these —for the Almansa-Valencia-Tarragona line—had a second story or "imperial," and was very similar to the double-storied cars in use on the Paris Suburban lines. How many of these double cars were in use could not be ascertained, but it was stated that they were very popular. They are well adapted to the climate, and it is a little surprising that they are not generally used.

In building freight cars—usually open trucks—a dozen will be laid down at a time, and the work on all carried on at once. They are usually built to carry 10,000 kilos., or about 22,000 lbs.

RAILROAD CONSOLIDATION.

The Almansa-Valencia-Tarragona line, referred to above—which is a line of considerable importance, built and owned by a company entirely Spanish—has just been consolidated with the Ferrocarril del Norte, also a Spanish company, with its headquarters in Madrid. With this incorporation the company becomes the leading Spanish railroad corporation, owning a little over 3,000 kilometers —1,865 miles—of road, chiefly single track. Its lines occupy the territory in the north and along the eastern or Mediterranean coast.

"EL PUENTE DEL DIABOLO," NEAR MARTORELLI, SPAIN.

The company which now drops back to second place is the Caminos-de-Hierro del Mediodia, which owns the lines from Madrid to Zaragoza, Alicante, Ciudad-Real and Badajoz, covering western and a large part of southern Spain. This company has an ownership largely French, and is an exclusive and somewhat unpopular concern. Both the companies mentioned have been made up of a number of short lines.

As with manufacturing concerns, it is difficult to get information, and a copy of the annual report of one of the great companies is not to be had. Perhaps it is because the results to stockholders have not been altogether satisfactory, and the managers do not want to say too much until matters have improved. The railroad consolidations, it may be said, have much simplified and improved the management.

THE LARGEST SAILING SHIP.

THE largest sailing ship in the world is the *Maria Rickmers*, which was launched on February 26 last from the yard of Russell & Company, at Port Glasgow, Scotland, and which has been built for the great shipping house of Rickmers, of Bremen.

This vessel is of steel, and is 375 ft. long over all, 48 ft. beam, and 28 ft. 5 in. deep. She will register 3,813 tons gross, and will have a carrying capacity of about 6,000 tons of freight. She has a double bottom and deep midship water tanks which will hold about 1,300 tons of water ballast. The equipment includes all the latest improvements in the way of hoisting gear, ventilators and other appliances.

The vessel has five masts and is bark rigged, carrying an enormous spread of canvas. In ordinary weather she

will be propelled by sails alone; but she is also provided with machinery for use in case of need. This consists of a triple-expansion engine with cylinders 16 in., 26 in. and 42 in. in diameter and 27 in. stroke. The propeller is of gun-metal, and is of the Bevis feathering type, which is expected to do away with the usual objection to auxiliary screws, that they act as a drag when the ship is under sail. On the trial trip, in ballast, this engine developed 650 H.P. with 160 lbs. of steam, and gave the ship a speed of 7½ knots.

Up to the completion of this ship, the largest sailing ship in the world was *La France*, a steel five-masted ship, built last year by Henderson & Son, at Glasgow, for a Bordeaux firm. *La France* is 361 ft. long, 48 ft. 8 in. beam, and registers 3,784 tons. The four-masted iron ship *Liverpool*, owned in Liverpool, is 333 ft. long, 47 ft. 9 in. beam, and 3,400 tons register. The largest wooden ship in existence is the *Shenandoah*, built and owned by Sewall & Company, of Bath, Me., which is 299 ft. 7 in. long, 49 ft. 1 in. beam, and 3,258 tons register; she has carried over 5,000 tons, and some time ago took the largest wheat cargo on record—112,000 centals, or 5,600 net tons—out of the port of San Francisco.

The *Maria Rickmers* is nearly ready for her first voyage, which will be to the East Indies, it is said, after a cargo of rice.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page* 221.)

AEROPLANES.

Aeroplanes—*i.e.*, thin fixed surfaces, slightly inclined to the line of motion, and deriving their support from the upward reaction of the air pressure due to the speed, the latter being obtained by some separate propelling device, have been among the last aerial contrivances to be experimented upon in modern times.

The idea of obtaining sustaining power from the air with a fixed, instead of a vibrating or a rotating surface is not obvious, and it was not till 1842 that an aeroplane, as we now understand the term, consisting of planes to sustain the weight, and of a screw to propel, was first proposed and experimented with. All aviators must have occasionally seen and marveled at the performances of the soaring varieties of birds, sailing in every direction at will upon rigidly extended wings (a performance concerning which more will be said in the progress of this discussion), but the flapping birds are so much more numerous and easily observed, their action is so much easier of comprehension, that they have been the favorite model.

We shall see, however, in reviewing old traditions with perhaps a new understanding, that such faint approximations to success, as have hitherto been attained with artificial flying machines, were probably accomplished with fixed surfaces, either by gliding downward by the force of gravity, or in soaring upon the wind like a bird.

Although aeroplanes have been among the last devices to be experimented upon, they are now the favorite apparatus from which success is hoped for, and later designs have chiefly been in this direction. The very important labors of Professor Langley have shown that with the exertion of 1 horse power as many as 200 lbs. can be sustained in the air by an aeroplane, while Mr. *Maxim* states, as the result of his many experiments, that at least 133 lbs. can be sustained per horse power. If we compare this with the results of vibrating wings, which may be assumed as supporting 77 lbs. per horse power,* or with screws, which have been shown as affording generally 33 to 40 lbs. per horse power—chiefly, as the writer believes, because of the greater angle of incidence or of pitch which is required with alternating or rotating surfaces—we see that fixed surfaces possess a marked advantage over movable surfaces. The latter, it is true, can probably be made somewhat smaller and hence lighter, but this advantage is likely to be more than counterbalanced by the greater power required to work them.

Still the fact remains that almost all experiments with aeroplanes have hitherto been flat failures. This is believed by the writer to result from the difficulty of maintaining the equilibrium of that form of apparatus, both sideways and fore and aft. There seems to be no very great difficulty in obtaining proper balance and equilibrium with flapping wings or with screw apparatus, the motion of the parts apparently compensating to some extent for the tendency to tilt over, but fixed aeroplanes seem much more unstable—a single flat plane, for instance, of uniform weight throughout, possessing no sort of stability whatever when in forward rectilinear motion.

Perhaps the reader will best understand this, and at the same time obtain a glimpse of some of the laws of aerial equilibrium under forward motion, by experimenting with an aeroplane of his own.

Let him cut out a strip or parallelogram of stiff wrapping paper—say 15 in. long and 3 in. wide. Its sides should be straight and parallel, and the surface a true flat plane, free from folds or wrinkles. In this condition it may fall flatways a short distance with tolerable steadiness; but if allowed to fall edgeways, or projected forward without whirling, it will at once rotate upon its long axis, tumble over and over, and be seen to have very unstable equilibrium. This can be remedied with very slight changes; for next paste upon one of the long edges of the plane a strip of pasteboard ½ of an inch wide and the same length as the paper plane. Part of an ordinary pasteboard box will do very well; but the important point to be observed is that the apparatus shall balance on its middle line, and at a point 28 to 30 per cent. back from its front edge, or say, ⅞ of an inch. When the paste is dry, make a very slight fold in the paper strip near the edge opposite to the pasteboard strip and parallel to it. Let this fold or crease be about ⅝ of an inch from the rear edge, and form an angle of about 10° with the plane of the paper. Next bend the aeroplane parallel with the short sides and exactly in the center of the long sides, so that the two halves shall also stand at a diedral angle of about 10° with each other, like a very obtuse letter V, care being taken that middle fold and the back fold shall be on the same side of the plane. It will then be noticed that the attitude of the apparatus somewhat resembles that of a soaring buzzard in the air minus its tail.

If, now, this aeroplane be allowed to drop edgeways, with the weighted side downward, from a height of 7 ft. or more, its behavior will be entirely different from that in its former condition. Instead of tumbling over and over, it will sail downward and forward upon a curve until the increasing pressure balances the weight, and then glide on a straight path to the floor, some 15 or 20 ft. from the operator. It may not glide on a straight line upon the first trial, but in that event very slight changes in the angles of the back crease and of the middle fold, and a smoothing out of the plane will be sure to produce the desired forward flight and steady glide.

Still better results can be obtained by pasting a strip of tin ¼ in. wide in a fold in the forward edge of a plane 4 in. wide. For this purpose it will be well to have the strip of tin 15 in. long, and to cut the paper plane 20 in. long by 5 in. wide, so that 1 in. of the latter can be folded quite over and pasted down over the tin. The latter should be accurately spaced 2½ in. from each end, so that the apparatus shall balance exactly on the middle line lengthways, and 1.2 in. from the weighted edge, crossways. The corners beyond the tin may be rounded off if desired, provided care be taken not to disturb the balance. Then by bending the apparatus very slightly in the center of its length, and turning up the rear edge about 10° in the same direction, an aeroplane will be produced which will sail steadily forward in still air, sweep to the right, if the right-hand back corner be slightly curved up, or go to the left when the left-hand corner is similarly treated.

The principle on which this aeroplane sails is the same as that upon which the bird glides downward on outstretched wings. The preponderance of the weight in

* Assuming a bird in horizontal flight to develop 425 ft. lbs. per minute for each pound of his weight, the sustaining reaction will be $\frac{33,000}{425} = 77$ lbs. per horse power.

front determines the angle of incidence, and brings the center of gravity to coincide with the center of pressure, the latter varying approximately as per Joëssel law, already given, which, however, it must be remembered, probably only applies to square planes; the horizontal component of the pressure (inasmuch as the plane is inclined forward) acts in the direction of the flight, and furnishes the motive power while the back fold supplies automatically the longitudinal stability by counteracting such tendency as the aeroplane may have to tilt fore and aft; and the diedral angle in the middle gives lateral stability, by reacting against the air on that side toward which the apparatus may begin to tip.

These compensations are effective in still air, but it may be doubted whether they are sufficient in the open air. When a bird soars in a gusty wind (and almost all winds are gusty and irregular in velocity near the surface of the ground), the automatic effects obtained by the diedral angle of the wings and the upward angle of the tail do not seem to act quickly enough. The bird will be seen, by observation at close range, to be almost constantly balancing himself by slight, almost unconscious movements. He advances the tips of his wings or thrusts them back; he flexes one or the other, and quite often he advances or draws back his head, or uses his legs as a pendule from the knee joint, in order to maintain his equilibrium. All birds are acrobats, but the soaring kind, if closely observed in a gusty wind, will be seen to perform feats of balancing more delicate and wonderful than those of any human equilibrist.

We shall hereafter see that even if the aeroplanes experimented with had been provided with adequate motors, as they were not, this difficulty in maintaining a proper equilibrium with fixed surfaces is probably sufficient to account for most of the failures of experiments upon a practical scale with that form of apparatus, and for their abandonment by their designers, a brief trial having probably satisfied them that aside from the question of a motive power, which they were confessedly unable to solve, they were not yet masters of such reasonable stability and command over their apparatus, as to warrant them in proceeding further. Now that the all-important question of a light motor seems to be in a fair way of being solved through the achievements of Mr. *Maxim*, M. *Trouvé*, and others who are known to be laboring in the same direction, the question of the equilibrium of aeroplanes increases in relative importance, and warrants making this somewhat prominent in criticising past experiments and proposals. For this and other reasons, we shall pass in review a number of mere designs as well as forms of apparatus which was actually subjected to the test of experiment, and endeavor to inquire into the causes of failure.

Failures, it has been said, are almost as instructive as successes, as intending to remove, if we can understand the cause, at least one of the difficulties in the way, and the reader will probably agree that there has been hitherto no lack of failures in aerial experiments.

There probably have been in all ages of the world men, whose imaginations were fired by the sight of the soaring birds, and some who tried to imitate them. In early times mechanical and mathematical knowledge was too crude to render such experiments numerous, and before the invention and diffusion of printing, even the records of such failures would generally perish; but a few legends have come down to us in abbreviated shape, which indicate that some then celebrated attempts and failures had taken place. No great faith can be attached to these legends, yet some of them are curious, if considered as the relation of attempts to sail upon the wind like soaring birds with rigid fixed surfaces.

Passing over as too scanty of record the myths of antiquity, perhaps the earliest legend of an experiment which we may fairly suppose to have been tried with an aeroplane is stated to be found in the somewhat fabulous chronicles of Britain,* wherein it is related that King *Bladud*, the father of King *Lear*, who is supposed to have reigned in Britain about the time of the founding of Rome, caused to be built an apparatus with which he sailed in the air above his chief city of Trinovante, but that, losing his balance, he fell upon a temple and was killed. This is about all there is of the legend, and as even that concerning King *Lear*, which Shakespeare worked up into his tragedy, has been suspected of being a myth, it is difficult to comment intelligently upon such a tradition; yet it is not impossible that King *Bladud* (who was reputed to be a wizard, as were all investigators in ancient times), should have attempted to imitate the ways of the eagle in the air, and should have succeeded in being raised by the wind, when, for lack of the balancing science of the bird, he should have lost his equilibrium, and with a shear, a plunge, or a whirl have come in disaster to the ground.

A better authenticated legend seems to be that of *Simon the Magician*, who, in the thirteenth year of the reign of the Emperor *Nero* (about 67 A.D.), undertook to rise toward heaven like a bird in the presence of everybody.* The legend relates that "the people assembled to view so extraordinary a phenomenon and *Simon* rose into the air *through the assistance of the demons* in the presence of an enormous crowd. But that St. Peter, having offered up a prayer, the action of the demons ceased, and the magician was crushed in the fall and perished instantly."

"It seems, therefore, certain" (adds M. *de Graffigny*) "from this tale, which has come down to us without any material alteration, that even in that barbarous age a man succeeded in rising into the air from the earth by some means which have unfortunately remained unknown."

The writer has seen the feat performed by soaring birds many times. He has seen a gull, standing upon a pile-head within 20 ft. of him, float up into the air without flapping, by simply facing the wind, opening his wings to their full extent, and keeping them rigidly extended to a sea breeze blowing at the rate of 14.40 measured miles per hour. The gull rose vertically about 2½ ft. above the pile-head, then drifted back about 5 ft., still rising slightly, when he altered by a trifle his angle of incidence, advanced against the wind, losing a little height, and was thenceforth in full soaring activity. Many other writers have seen the same kind of performance, including the still more difficult feat seen by M. *Mouillard*,† who observed in Africa an eagle spring from the top of an ash-tree, and without a single flap first descend from 7 to 10 ft., going against the wind, and upon this freshening to a squall, rise directly and slowly some 300 ft. into the air, while *advancing against the wind* some 150 ft. at the same time.

The reader may be further interested by the account of a somewhat similar feat, published in *L'Aéronaute* of October, 1890, by Mr. *Charles Weyher*, and which he describes as follows:

"One day when I was close to the Aqueduct of *Buc*, and the wind was blowing strongly down the valley, and therefore at right angles to the aqueduct, I saw a sparrow hawk come out of a hole marked *A* (fig. 36) on the sketch,‡ near the top, and on the leeward side.

"The bird left his hole and dove downward, his wings scarcely opened, and thus reached like a dart a point about the center of the opening of one of the arches. At this moment, when at *B*, he stretched his wings wide open and began circling, continued his orbits, drifting with the wind, until he attained an elevation of 800 to 1,000 ft. At this elevation, or the point *C*, the sparrow hawk folded his wings almost completely and dove forward again upon a steep inclination, making use of the height gained to recover against the wind the distance which he had drifted, and to regain his hole, into which he entered gently, by simply opening his wings wide when within 7 to 10 ft. of the wall.

"It is well to observe that the bird in taking this journey, both going and coming back, expended no muscular work whatever, save the utterly inappreciable exertion of opening and folding up his wings twice."

The legend of *Simon the Magician*, which has led to the above digression, is clearly of Christian origin, as evidenced by the intervention of St. Peter, who is supposed to have been martyred in Rome about A D. 64. It is not known to be confirmed by any Roman record, such records having been largely destroyed during the dark ages; but

* Bescherelle, Histoire des Ballons, 1852.

* Graffigny, La Navigation Aérienne, 1888.
† Mouillard, L'Empire de l'Air, 1881. Page 22.
‡ See following page for this sketch.

if the tradition be founded upon a fact, we may suppose *Simon*, after some preliminary trials, to have attempted to imitate, with a fixed aeroplane, in public some of the evolutions of a soaring bird, and being unable to perform skillfully the necessary manœuvres, to have lost his equilibrium and his life.

There is another monkish tradition of the eleventh century concerning *Oliver of Malmesbury*, who in some of the accounts is styled "Elmerus de Malemaria," and who was an English Benedictine monk, said to have been a deep student of mathematics and of astrology, thereby earning the reputation of a wizard. The legend relates * that

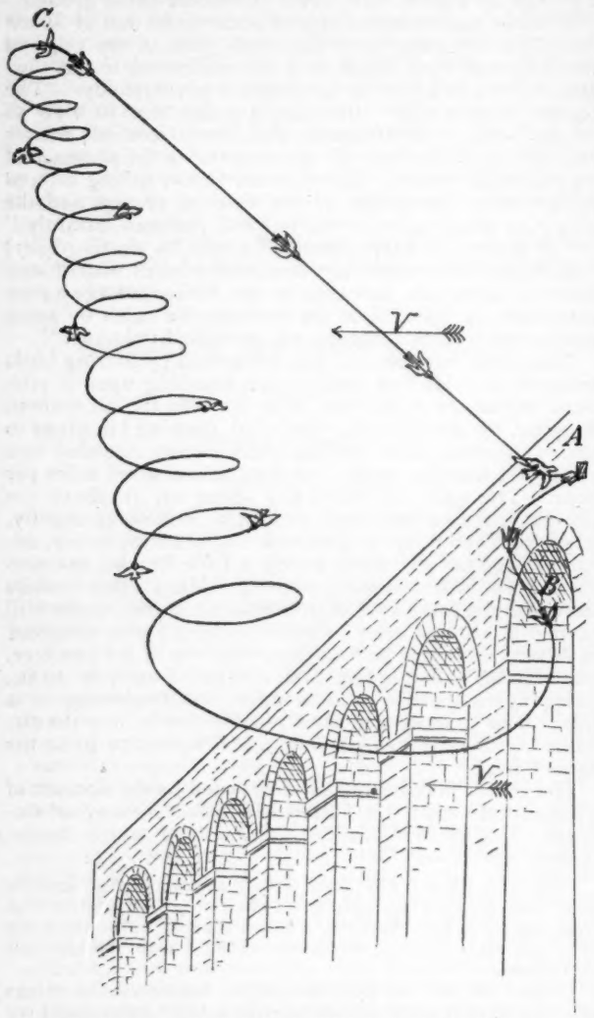


FIG. 36.—THE SPARROW-HAWK'S EXCURSION.

"having manufactured some wings, modeled after the description that *Ovid* has given of those of *Dedalus*, and having fastened them to his hands, he sprang from the top of a tower against the wind. He succeeded in sailing a distance of 125 paces; but either through the impetuosity or whirling of the wind, or through nervousness resulting from his audacious enterprise, he fell to the earth and broke his legs. Henceforth he dragged a miserable, languishing existence (he died in 1060), attributing his misfortune to his having failed to attach a tail to his feet."

Commentators have generally made merry over this last remark, but in point of fact it was probably pretty near the truth. To perform the manœuvre described, of gliding downward against the breeze, utilizing both gravity and the wind, *Oliver of Malmesbury* must have employed an apparatus somewhat resembling the attitude of a gliding bird, but being unable to balance himself fore and aft, as does the bird by slight movements of his wings, head and legs, he would have needed even an ampler tail than the bird spreads on such occasions in order to maintain his equilibrium. He would have failed of true flight in any event, but he might have come down in safety.

A more explicit tradition of the same kind comes from Constantinople, where, under the reign of the Emperor *Manuel Comnenus*, probably about the year 1178, a *Saracen* (reputed to be a magician of course), whose name is not given, undertook to sail into the air from the top of the tower of the Hippodrome in the presence of the Emperor.

The quaint description of this attempt, as taken from the history of Constantinople by *Cousin*, and given both by *Graffigny* and by *Bescherelle*, so clearly describes an aeroplane as distinguished from movable wings, and so well indicates the difficulty of obtaining and maintaining a proper balance with such an apparatus, that it is worth quoting:

"He stood upright, clothed in a white robe, very long and very wide, whose folds, stiffened by willow wands, were to serve as sails to receive the wind. All the spectators kept their eyes intently fixed upon him, and many cried, 'Fly, fly, O Saracen! do not keep us so long in suspense while thou art weighing the wind!'—*i.e.*, adjusting the angle of incidence and the equilibrium of the machine.

"The Emperor, who was present, then attempted to dissuade him from this vain and dangerous enterprise. The Sultan of Turkey in Asia, who was then on a visit to Constantinople, and who was also present at this experiment, halted between dread and hope, wishing on the one hand for the Saracen's success, and apprehending on the other that he should shamefully perish. *The Saracen kept extending his arms to catch the wind.* At last, when he deemed it favorable, *he rose into the air like a bird;* but his flight was as unfortunate as that of *Icarus*, for the weight of his body having more power to draw him downward than his artificial wings had to sustain him, he fell and broke his bones, and such was his misfortune that instead of sympathy there was only merriment over his misadventure."

This account seems to be given with such circumstance as to preclude the idea that it is merely the idle tale of some lover of the marvelous. We may, therefore, fairly seek to draw some inferences therefrom, which have not been heretofore mentioned by other writers. The first is that the apparatus was some form of aeroplane, because it is likened to a robe instead of a pair of wings, and also because no mention whatever is made of any flapping action. The only active exertion described on the part of the operator is that of the adjustment of the apparatus to the prevailing wind, implying that it was so adjustable that the angle of incidence might be regulated to obtain an ascending effect, and the center of pressure be brought to coincide with the center of pressure to produce fore and aft equilibrium. The second inference is that the force of the wind was the only motive power relied upon, and that the apparatus was not blown away, but rose upon the wind like the gull which has been already described. This being possibly an instance of that mysterious phenomenon of "Aspiration" which was alluded to at the beginning of this account of "Progress in Flying Machines," and which will be found further exemplified when an account is given of the various experiments of Captain *Le Bris*. The third inference is that the defect lay in the maintenance of the equilibrium. That the apparatus started off properly balanced, but that so soon as a change occurred in the conditions, perhaps an erroneous manœuvre on the part of the Saracen, or perhaps a gust of wind on one side, the aeroplane lost its balance, and disaster ensued.

Only brief allusion need be made in this discussion to the writings of *Roger Bacon*, the eminent philosopher of the thirteenth century (1214–94). He seems to have prophesied both the balloon and the flying machine, but not to have tried or related any experiments. His writings will be found noticed in some of the encyclopædias, and in Wise's "History and Practice of Aeronautics," the latter book containing, moreover, references to the traditions which have here been mentioned, as well as to others which have been omitted.

One of the most celebrated traditions of partial success with a flying machine refers to *J. B. Dante*, an Italian mathematician of Perugia, who toward the end of the fourteenth century seems to have succeeded in constructing a set of artificial wings with which he sailed over the neigh-

* Bescherelle, Histoire des Ballons.

boring lake of Trasimene.* We have no description of the apparatus, but this was presumably an aeroplane, soaring upon the wind, for we have seen abundantly that all experiments have failed with flapping wings, man not having the strength required to vibrate with sufficient rapidity a surface sufficient to carry his weight in the air. Moreover, there would be a stronger and steadier wind over a lake than over the land, and the selection of a sheet of water to experiment over was very happy, as it would furnish a yielding bed to fall into if anything went wrong, as is pretty certain to happen upon the first trials. A similar selection has been recommended by *D'Esterno* and by *Mouillard*, and cannot be too strongly urged upon any future inventor who desires to make similar experiments. With adequate extent of surfaces, and (if he goes up at all) some prudence as to the height to which he allows the wind to carry him, he can thus acquire some insight into the science of the birds, with no greater danger than that of numerous duckings.

Whether *Dante* grew overbold with some preliminary successes, or whether he was impatient to display his achievement before his fellow-citizens and his sovereign, he attempted to repeat the feat in Perugia, on the occasion of the marriage of *Bartholomew Alviano* with the sister of *Jean Paul Baglioni*. Starting from the top of the highest tower in the city of Perugia, he sailed across the public square and *balanced himself for a long time in the air*, amid the acclamations of the multitude. Unfortunately the iron forging which managed his left wing suddenly broke, so that he fell upon Notre Dame Church and had one leg broken. Upon his recovery he seems to have given up further experiment, but went to teach mathematics at Venice, where he died of a fever before he had reached forty years of age.

Granting the tradition to be true, the apparatus used by *Dante* must have been more manageable than any of its predecessors, for the accident is said to have been due to a breakage instead of a loss of balance. The latter, however, must have been still deficient, or *Dante* would have renewed his experiments with a stronger forging. He may have reasoned, moreover, that as the wind does not blow with the requisite speed every day, and he knew of no sufficiently light motor to take its place, the use of a soaring machine would be very limited; but it is very unfortunate that we should have no description of the machine and its mode of operation.

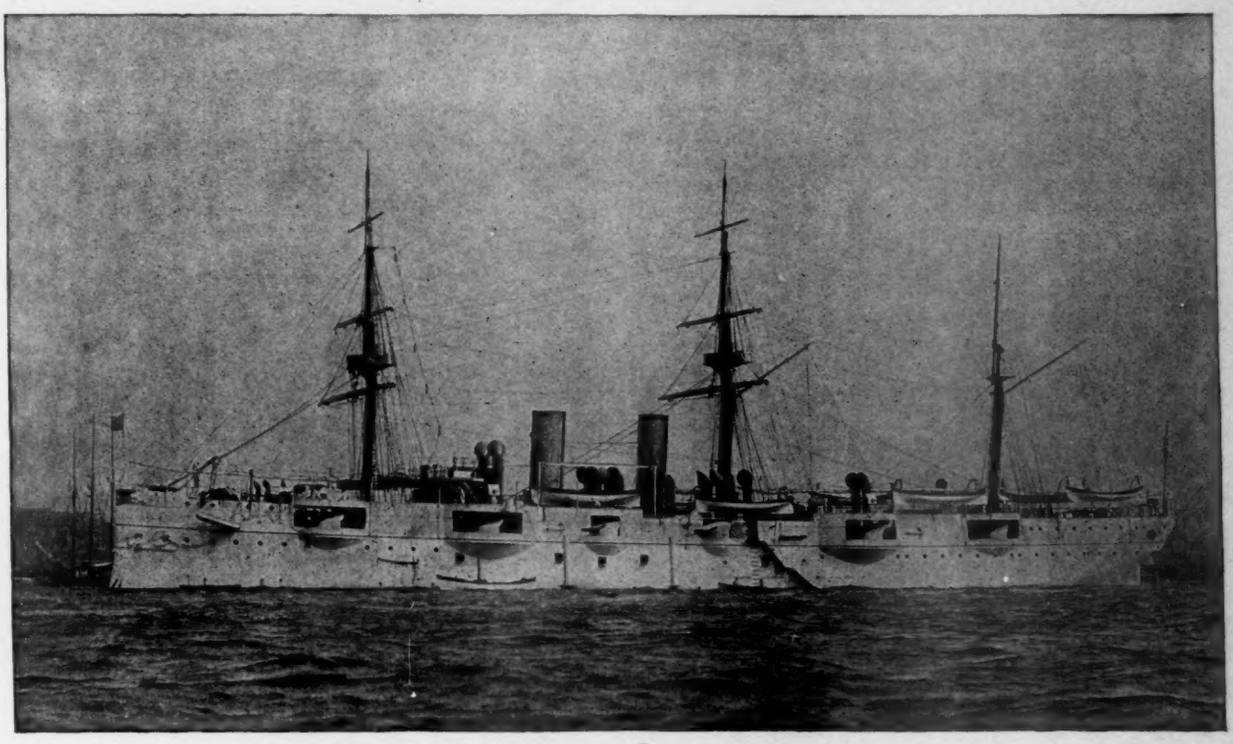
(TO BE CONTINUED.)

* Tissandier, La Navigation Aérienne. Bescherelle, Histoire des Ballons.

THE CRUISER "NEWARK."

THE accompanying illustration is from a photograph of the *Newark*, one of the first of the large cruisers ordered for the Navy, and the first entirely designed by the Department. The general appearance of the ship, the number of masts, etc., are shown by the engraving.

The *Newark* was built at the Cramp yards, in Philadelphia, and was launched in March, 1891. She is a steel cruiser with twin screws, and her principal dimensions are: Length over all, 329 ft.; length on load water-line, 310 ft.; molded breadth, 49 ft.; extreme breadth, 49.14 ft.; depth from flat keel plates to under side of spar-deck, 31.80 ft.; mean draft, 18 825 ft.; displacement to load water-line, 4,083 tons; tons per inch at load water-line, 24 96; area of load water-plane, 10,481 sq. ft.; area of immersed midship section, 807.23 sq. ft.



CRUISER "NEWARK," UNITED STATES NAVY.

The battery consists of ten 6-in. rifled cannon mounted on central pivot carriages. None of these guns are mounted on the forecastle or poop-deck, but are carried underneath each of these decks. There is also a heavy secondary battery of rapid-fire and machine guns.

The motive power is furnished by two triple-expansion engines, one to each screw, having cylinders 34 in., 48 in. and 76 in. in diameter and 40 in. stroke. There are four boilers 13 ft. 6 in. in diameter and 19 ft. 6 in. long, intended to carry a working pressure of 160 lbs. The engines work up to about 6,000 H.P. with natural draft and 8,500 H.P. with forced draft. The ship has made over 19 knots an hour.

The *Newark* has seen some sea service; she is at present in the Atlantic Squadron, and is cruising among the West Indies. She is one of the most symmetrical vessels in the Navy in appearance.

THREE-RAIL TURNOUTS FOR DOUBLE-GAUGE TRACKS.

By James K. Geddes, C.E.

(Copyright, 1892, by M. N. Forney.)

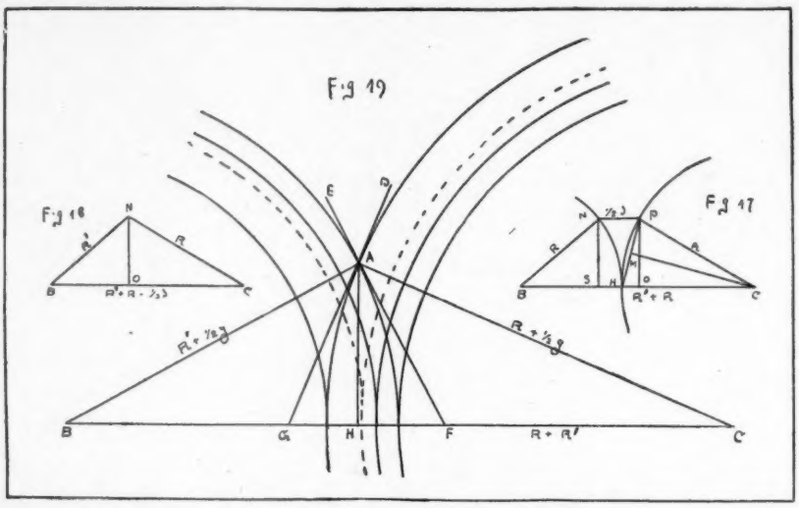
(*Continued from page 226.*)

TURNOUTS FROM THE OUTSIDE OF CURVES.

As with turnouts from the inside of curves, we will consider the subject as coming under two cases.

CASE I.

Under this head we will consider the case where the main track curve is to the right, with the turnout curve to the left, with the third rail on the right of the center, as shown in fig. 19.



LENGTH OF THROW-RAILS.

In fig. 17 let $H P$ represent the center line of main track and $H N$ the center line of turnout curve, R the radius of main track, R' the radius of the turnout curve, and assume $N P = \frac{1}{2} d$ as the throw. The trapezoid $B N P C$ is equivalent to the triangles $B N S$ and $P O C$ and the parallelogram $N P S O$. Subtracting the parallelogram $N P S O$, we have the oblique triangle $B N C$, fig. 18, where the side $B N = R'$, $N C = R$ and $B C = R + R' - \frac{1}{2} d$.

$$\text{Let } s = \frac{R' + (R + R' - \tfrac{1}{2} d) + R}{2},$$

Then from trigonometry,

$$\textit{Sin.}\ \tfrac{1}{2} N C O = \sqrt{\frac{[s - (R + R' - \tfrac{1}{2} d)]\,[s - R]}{R \times (R + R' - \tfrac{1}{2} d)}}.$$

But the *sin.* $\frac{1}{2} N C O$ is equal to the *sin.* $P C M$ in the right-angled triangle $M C P$, where $P M$ is equal to the half chord of the throw-rail, and from trigonometry,

$$P M = R \times \textit{sin.}\ P C M. \qquad (21)$$

Example: Given the radius of main track, $R = 955.37$, the radius of turnout track $R' = 716.78$, and the throw $\frac{1}{2} d = 5$ in. $= 0.417$ ft., to find the length of chord of throw-rail $P H$.

Here

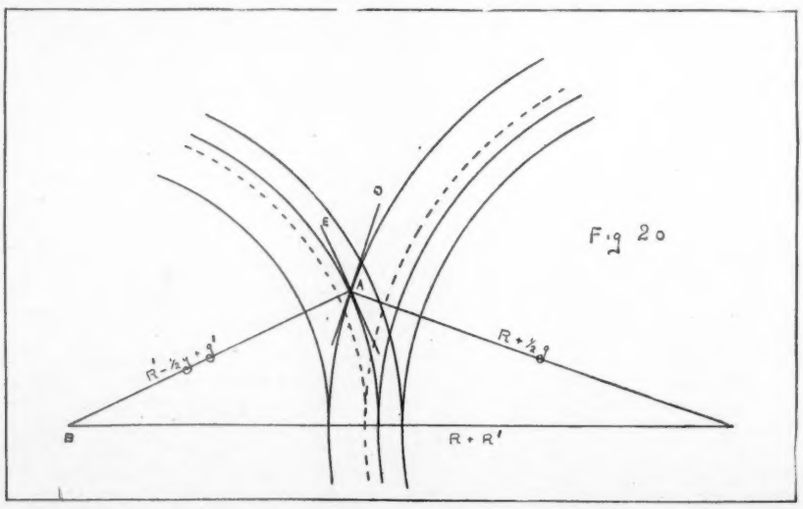
$$s = \frac{716.78 + (955.37 + 716.78 - 0.417) + 955.37}{2} = 1671.941$$

$s - (R + R' - \frac{1}{2} d) = 0.208$.....	$\bar{1}.3180633$
$s - R = 716.571$.....	2.8552592
$R = 955.370$ ar. comp.....	7.0198284
$R + R' - \frac{1}{2} g = 1671.733$ ar. comp.	6.7768331
Extracting sq. root.....	$2)\overline{15.9699840}$
Sin. $\frac{1}{2} N C O = 0°\ 33'\ 13''$.....	7.9849920

Then in the right-angled triangle $M C P$,

$R = 955.37$.....	2.9801716
$P C M = 0°\ 33'\ 13''$..... *sin.*	7.9849920
$P M = 9.229 = 9'\ 2\frac{3}{4}''$.....	0.9651636

whence $P H = 18'\ 5\frac{1}{2}''$.



The length of the arc $H P$ may be found in the manner described in Eq. 8.

To find the frog angles $D A E = G A F$, fig. 19, of the first frog, given the radius of main track $= R$, the radius of a turnout track $= R'$, the standard gauge $= g$ and the narrow gauge $= g'$.

In the case of a turnout from the outside of a curve in

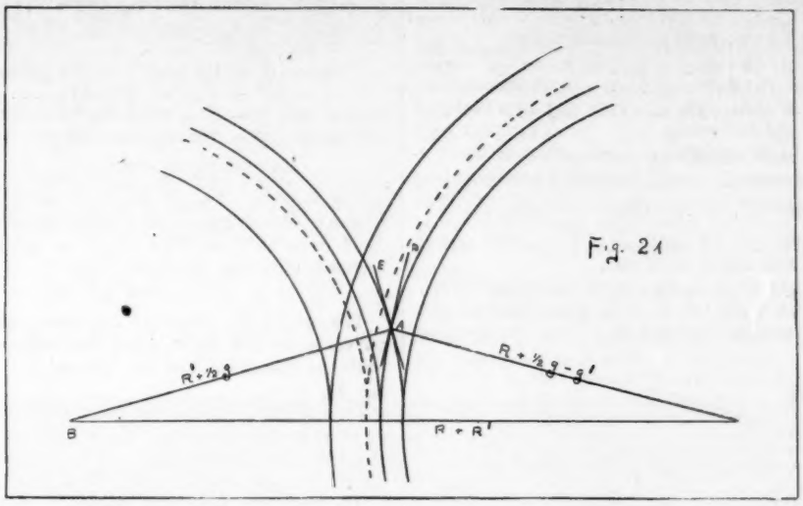
different directions, the frog angle is equal to the sum of the two central angles.

Thus the angle $C\,A\,G = A\,H\,C$, also the angle $C\,A\,G = C\,A\,H + H\,A\,G$ and the angle $A\,H\,C = C\,A\,H + H\,C\,A$, from which the angle $H\,C\,A = H\,A\,G$.

Likewise the angle $B\,A\,F = B\,H\,A$, also the angle $B\,A\,F = B\,A\,H + H\,A\,F$ and the angle $B\,H\,A = B\,A\,H + H\,B\,A$, from which the angle $H\,B\,A = H\,A\,F$. The angles $H\,C\,A + H\,B\,A = H\,A\,G + H\,A\,F$ and the angles $H\,A\,G + H\,A\,F = G\,A\,F = D\,A\,E$.

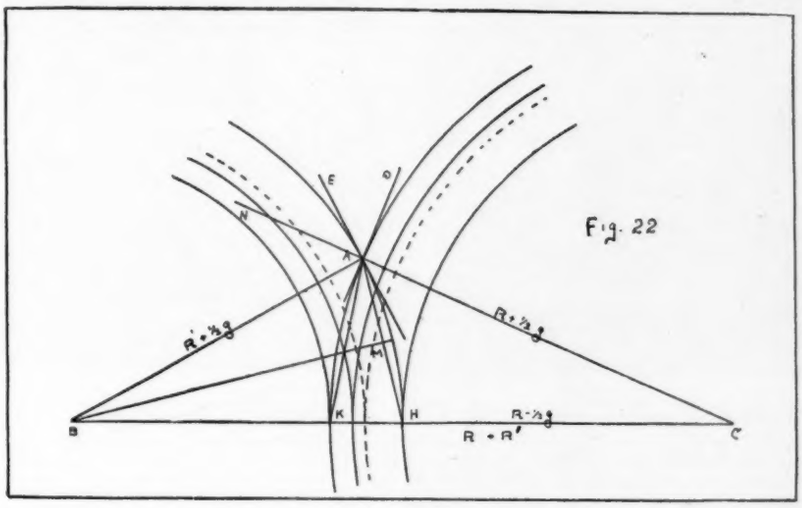
For convenience of calculation, we may at once find the angle $B\,A\,C$ and subtracting which from 180°, we have the frog angle $D\,A\,E$.

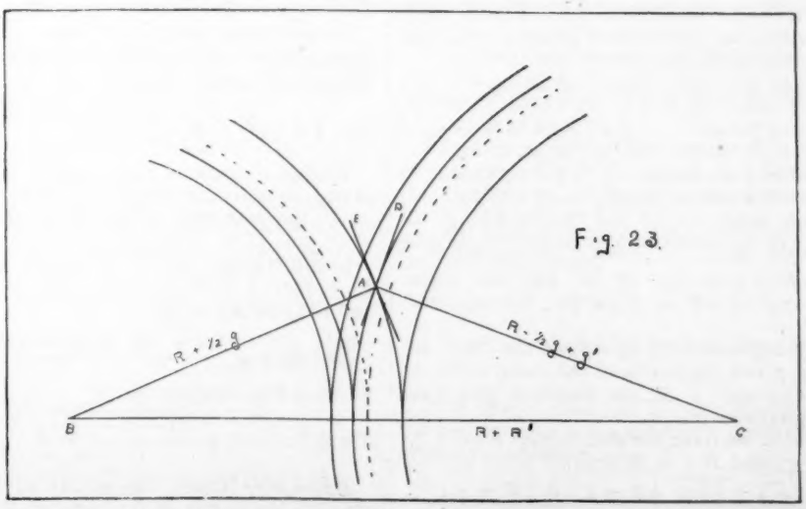
In the triangle $B\,A\,C$ we have the side $B\,A = R' + \frac{1}{2}g$,



$A\,C = R + \frac{1}{2}g$ and $B\,C = R + R'$ to find the angle $B\,A\,C$.

Let $$s = \frac{(R + R') + (R + \frac{1}{2}g) + (R' + \frac{1}{2}g)}{2}.$$





Then from trigonometry,

$$Sin.\ \tfrac{1}{2}B\,A\,C = \sqrt{\frac{[s - (R + \frac{1}{2}g)]\ [s - (R' + \frac{1}{2}g)]}{(R + \frac{1}{2}g)\ (R' + \frac{1}{2}g)}}. \quad (22)$$

Example: Given the radius of the main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, and the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ to find the frog angle $D\,A\,E$, fig. 19:

$$s = \frac{(2864.93+763.84)+(2864.93+2.354)+(763.84+2.354)}{2} = 3631.124$$

$s - (R + \frac{1}{2}g) = 763.840$.....	2.8830024
$s - (R' + \frac{1}{2}g) = 2864.930$.....	3.4571141
$R + \frac{1}{2}g = 2867.284$ ar. comp.	6.5425292
$R' + \frac{1}{2}g = 766.194$ ar. comp.	7.1156612
Extracting sq. root.....	2)19.9983069
$\frac{1}{2}\,B\,A\,C = 86°\ 25'\ 25''$. .....*sin.*	9.9991534

whence $B\,A\,C = 172°\ 50'\ 50''$ and $D\,A\,E = 180° - 172°\ 50'\ 50'' = 7°\ 09'\ 10''$, the angle required.

To find the frog angle $D\,A\,E$, fig. 20, of the second frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\,A\,C$ there are given the side $B\,A = R' - \frac{1}{2}g + g'$, $A\,C = R + \frac{1}{2}g$ and $B\,C = R + R'$.

Letting

$$s = \frac{(R + R') + (R + \frac{1}{2}g) + (R' - \frac{1}{2}g + g')}{2}$$

from trigonometry,

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s-(R+\frac{1}{2}g)]\,[s-(R'-\frac{1}{2}g+g')]}{(R+\frac{1}{2}g)\,(R'-\frac{1}{2}g+g')}}. \quad (23)$$

Example: Given the radius of main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft., to find the frog angle $D\,A\,E$, fig. 20:

$$s = \frac{(2864.93+763.84)+(2864.93+2.354)+(763.84-2.354+3.00)}{2} = 3630.270$$

$s - (R + \frac{1}{2}g) = 762.986$.....	2.8825166
$s - (R' - \frac{1}{2}g + g') = 2865.784$...	3.4572434
$R + \frac{1}{2}g = 2867.284$ ar. comp.	6.5425292
$R' - \frac{1}{2}g + g' = 764.486$ ar. comp..	7.1166305
Extracting sq root.....	2)19.9989197
$\frac{1}{2}\,B\,A\,C = 87°\ 08'\ 34''$.....*sin.*	9.9994598

whence the angle $B\,A\,C = 174°\ 17'\ 08''$ and the angle $D\,A\,E = 180° - 174°\ 17'\ 08'' = 5°\ 42'\ 52''$, the required answer.

To find the frog angle $D\,A\,E$, fig. 21, of the third or double-pointed frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\,A\,C$ we have the side $B\,A = R' + \frac{1}{2}g$, $A\,C = R + \frac{1}{2}g - g'$, and $B\,C = R + R'$.

Letting $s = \dfrac{(R+R') + (R+\frac{1}{2}g-g') + (R'+\frac{1}{2}g)}{2}$

we have from trigonometry

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s-(R+\frac{1}{2}g-g')]\ [s-(R'+\frac{1}{2}g)]}{(R+\frac{1}{2}g-g')\,(R'+\frac{1}{2}g)}}. \quad (24)$$

Example: Given the radius of the main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft., to find the frog angle $D\,A\,E$, fig. 21:

$$s = \frac{(2864.93+763.84)+(2864.93+2.354-3.00)+(763.84+2.354)}{2} = 3629.624$$

$s - (R + \frac{1}{2}g - g') = 765.340$...	2.8838544
$s - (R' + \frac{1}{2}g) = 2863.430$.....	3.4568865
$R + \frac{1}{2}g - g' = 2864.284$ ar. comp.	6.5429840
$R' + \frac{1}{2}g = 766\ 194$ ar. comp.	7.1156612
Extracting sq. root.....	2)19.9993861
$\frac{1}{2}\,B\,A\,C = 87°\ 50'\ 45''$.....*sin.*	9.9996930

whence the angle $B\,A\,C = 175°\ 41'\ 30''$ and the angle $D\,A\,E = 180° - 175°\ 41'\ 30'' = 4°\ 18'\ 30''$, the required answer.

CASE II.

We will now consider the case where the main track curve is to the right, with the turnout curve to the left, with the third rail on the left of the center, as shown in fig. 22.

In a similar manner to that employed in Case I., it may be shown that the frog angle $D\,A\,E = A\,B\,C + A\,C\,B$, and also, as in this case, for convenience, we at once calculate the angle $B\,A\,C$ and find $D\,A\,E = 180° - B\,A\,C$.

To find the first frog angle $D\,A\,E$, fig. 22, given the radius of the main track $= R$, the radius of the turnout curve $= R'$, and the standard gauge $= g$.

In the triangle $B\,A\,C$ there are given $B\,A = R' + \frac{1}{2}g$, $A\,C = R + \frac{1}{2}g$ and $B\,C = R + R'$, to find the angle $B\,A\,C$.

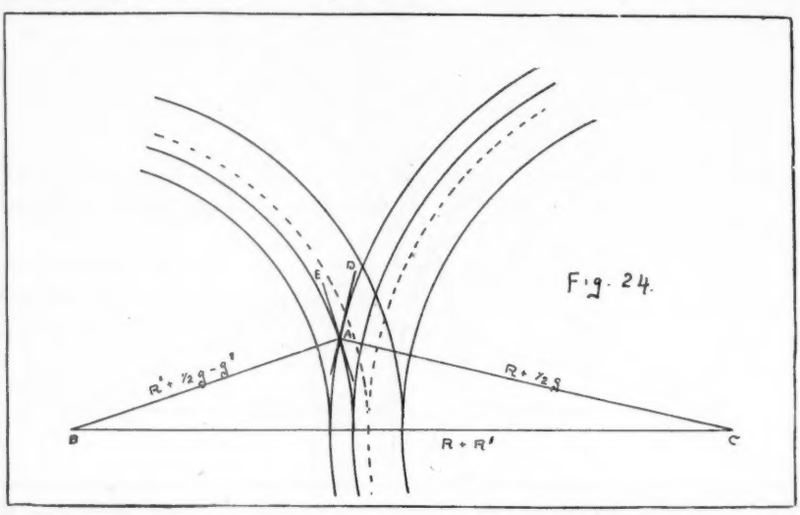


Fig. 24.

Since these sides are the same as in Eq. 22, the angles must also be equal, and therefore the angle $B\,A\,C$ may be found by the same equation—viz.:

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s-(R+\frac{1}{2}g)]\ [s-(R'+\frac{1}{2}g)]}{(R+\frac{1}{2}g)\,(R'+\frac{1}{2}g)}}.$$

To find the second frog angle $D\,A\,E$, fig. 23, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\,A\,C$ there are given the side $B\,A = R' + \frac{1}{2}g$, $A\,C = R - \frac{1}{2}g + g'$, and $B\,C = R + R'$, to find the angle $B\,A\,C$.

Letting $s = \dfrac{(R+R') + (R-\frac{1}{2}g+g') + (R'+\frac{1}{2}g)}{2}$

we have from trigonometry,

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s-(R-\frac{1}{2}g+g')]\ [s-(R'+\frac{1}{2}g)]}{(R-\frac{1}{2}g+g')\,(R'+\frac{1}{2}g)}}. \quad (25)$$

Example: Given the radius of the main track $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft., to find the frog angle $D\,A\,E$, fig. 23:

$$s = \frac{(2864.93+763.84)+(2864.93-2.354+3.00)+(763.84+2.354)}{2} = 3630.270$$

$s - (R - \frac{1}{2}g + g') = 764.694\ldots$	2.8834877
$s - (R' + \frac{1}{2}g) = 2864.076\ldots\ldots$	3.4569845
$R - \frac{1}{2}g + g' = 2865.576$ ar. comp.	6.5427881
$R' + \frac{1}{2}g = 766.194$ ar. comp. $\ldots\ldots$	7.1156612
Extracting sq. root $\ldots\ldots\ldots$	2)19.9989215
$\frac{1}{2}BAC = 87° 08' 43'' \ldots\ldots\ldots sin.$	9.9994607

whence the angle $BAC = 174° 17' 26''$ and the angle $DAE = 180° - 174° 17' 26'' = 5° 42' 34''$, the angle required.

To find the third or double-pointed frog angle DAE, fig. 24, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle BAC, we have given the side $BA = R' + \frac{1}{2}g - g'$, $AC = R + \frac{1}{2}g$, and $BC = R + R'$.

Let $s = \dfrac{(R + R') + (R + \frac{1}{2}g) + (R' + \frac{1}{2}g - g')}{2}$.

Then from trigonometry

$$Sin.\ \tfrac{1}{2}BAC = \sqrt{\frac{[s-(R+\frac{1}{2}g)]\ [s-R'+\frac{1}{2}g-g')]}{(R+\frac{1}{2}g)\ (R'+\frac{1}{2}g-g')}}. \quad (26)$$

Example: Given the radius of the main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4\ 708$, and the narrow gauge $g' = 3$ ft., to find the frog angle DAE, fig. 24:

$$s = \frac{(2864.93 + 763.84) + (2864.93 + 2.354) + (763.84 + 2.354 - 3.00)}{2} = 3629.624$$

$s - (R + \frac{1}{2}g) = 762.340\ldots\ldots$	2.8821487
$s - (R' + \frac{1}{2}g - g') = 2866.430\ldots$	3.4573414
$R + \frac{1}{2}g = 2867.284$ ar. comp. $\ldots\ldots$	6.5425292
$R' + \frac{1}{2}g - g' = 763.194$ ar. comp.	7.1173650
Extracting sq. root $\ldots\ldots\ldots$	2)19.9993843
$\frac{1}{2}BAC = 87° 50' 34'' \ldots\ldots\ldots sin.$	9.9996921

whence the angle $BAC = 175° 41' 08''$ and the angle $DAE = 180° - 175° 51' 08'' = 4° 18' 52''$, the answer required.

(TO BE CONCLUDED.)

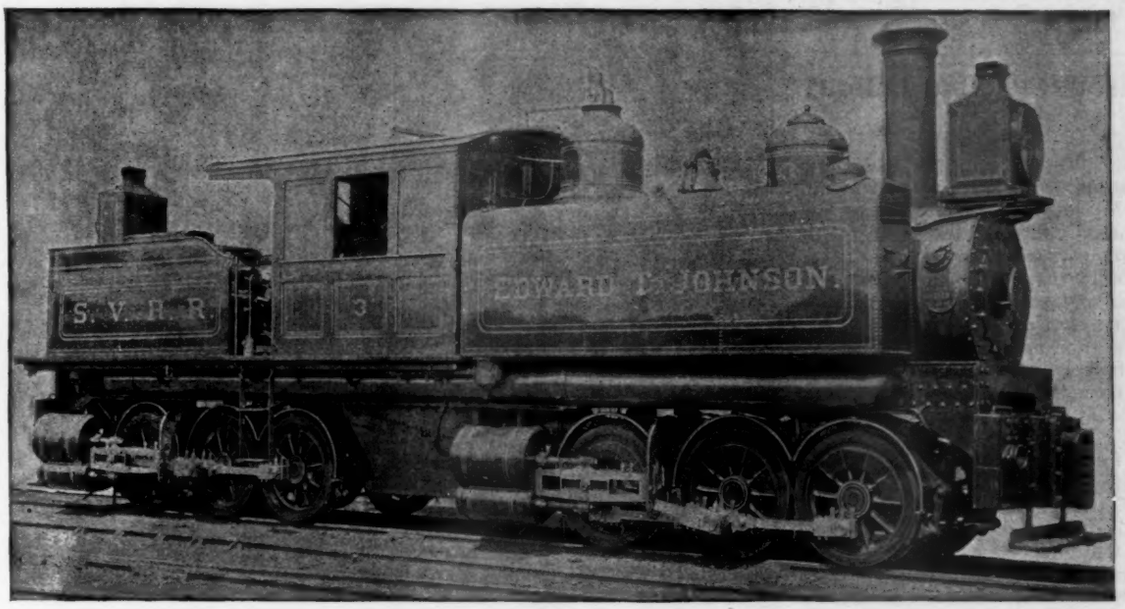
A DOUBLE-TRUCK COMPOUND LOCOMOTIVE.

THE accompanying illustration is from a photograph of a locomotive of exceptional type, recently built by the Baldwin Locomotive Works, in Philadelphia, for the Sinnemahoning Valley Railroad, a short line in Northwest Pennsylvania, having very heavy grades and sharp curves.

The entire weight of the engine is carried on 12 driving-wheels arranged in two groups of six, each group with its cylinders working in a separate frame and forming a truck or bogie. It differs from the Fairlie double-bogie engine in having a boiler of the ordinary form, and rather resembles the double-truck engines which were built by the late William Mason at Taunton several years ago.

Each truck has four cylinders, the engine being a compound of the Vauclain type. Steam is carried to the rear cylinders by a steam-pipe under the running-board. Water is carried in two side tanks and in a tank on the rear end of the frame. The engine is of the standard 4 ft. $8\frac{1}{2}$ in. gauge.

The boiler is 50 in. diameter of barrel, and has 167 tubes 2 in. in diameter and 12 ft. long. The fire-box is 66 in. long and $47\frac{3}{8}$ in. wide inside, the depth being $59\frac{1}{2}$ in. at the front end and 40 in. at the back.



DOUBLE-TRUCK COMPOUND LOCOMOTIVE BY THE BALDWIN LOCOMOTIVE WORKS.

The high-pressure cylinders are $9\frac{1}{2}$ in. and the low-pressure 16 in. in diameter, all being 18 in. stroke. The driving-wheels are 40 in. in diameter. The rigid wheel-base of each truck is 7 ft. 6 in.; the total wheel-base is 27 ft. 6 in.

The tanks will hold 2,500 galls. of water, 1,600 in the two side-tanks and 900 in the tank on the rear end. The engine is intended to run in either direction, and has a headlight on each end.

The total weight of this engine with tanks full and three gauges of water in the boiler, but without fire, is 150,400 lbs.; of this 72,100 lbs. are carried on the front section or truck, and 78,300 lbs. on the back section, the average weight per wheel being 6 tons on the front and $6\frac{1}{2}$ tons on the back section.

COLUMBIAN EXPOSITION NOTES.

IT is stated that the Krupp Works at Essen, Prussia, are preparing a large exhibit. Much of it will consist of ordnance, chiefly naval.

THE Youngstown Bridge Company, Youngstown, O., has taken a contract for an iron building 46 × 86 ft. in size, to be used as a boiler-house at the Exposition.

THE Rensselaer Polytechnic Institute, Troy, N. Y., is

preparing an exhibit intended to show the work done by its graduates in various parts of the world, as well as the work and methods of the Institute itself.

THREE traveling cranes, each of 20-tons capacity, are to be built for Machinery Hall. They will be used for moving heavy machinery into place before the opening, and will afterward be employed in carrying passengers from one end of the hall to the other in cars made for the purpose and lifted up from the floor. These cranes are to be operated by electric motors. They will be built by the Edge Moor Bridge Works, Wilmington, Del.; the Yale & Towne Manufacturing Company, Stamford, Conn.; and the Morgan Engineering Company, Alliance, O.

MISSOURI PACIFIC FREIGHT CAR TRUCK.

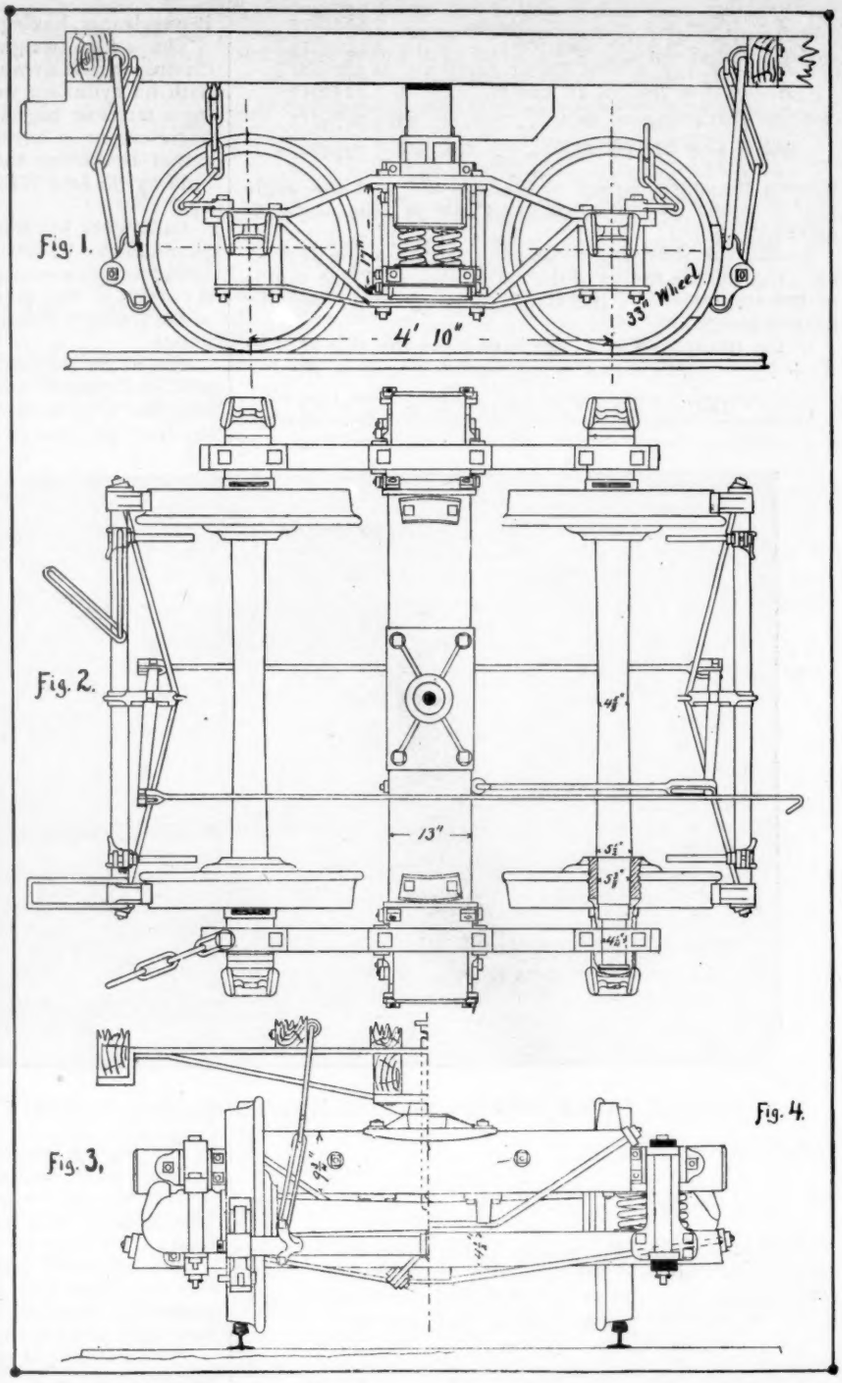
THE accompanying drawings show the standard freight car truck which the Missouri Pacific Company has adopted for its latest designs of freight cars, which are usually of 60,000 lbs. capacity. The drawings are so complete that little description is required.

The timbers are of white oak, the top bolster being 9¼ × 13 in., and 7 ft. 10 in. long, and the spring-plank 4½ × 13 in. and also 7 ft. 10 in. long. The journal-boxes are standard for 60,000-lbs. cars, and have the Hewitt lid. The axles are the M. C. B. standard, with 4¼ × 8-in. journals; they are 5⅜ in. diameter at the wheel-seat and 4⅝ in. at the center. The center plate is of malleable iron. The wheels are 33 in. in diameter and are spaced 4 ft. 10 in. between centers.

The National hollow brake-beam is used; and the arrangement of the brake gear is shown on the drawings.

The top arch-bar is 4 × 1¼ in.; the middle bar, 4 × 1⅛ in. and the tie-bar, 4 × ¾ in. The upper and lower truss-rods are respectively 1⅛ in. and 1 in. in diameter.

The truck is a very good design; it is based upon practice, and has done excellent service. It was designed under the direction of Mr. Frank Rearden, Superintendent of the Locomotive and Car Department, and is used for all classes of freight cars.



STANDARD FREIGHT CAR TRUCK, MISSOURI PACIFIC RAILROAD.

A HAWAIIAN TRESTLE BRIDGE.

WE are indebted to Mr. C. L. Wight, President and Manager of the Hawaiian Railroad, for the photograph from which the accompanying sketch has been prepared; it shows a trestle bridge built to carry a flume across a ravine on the Onomea sugar estate in the Hilo District in the Hawaiian Islands. The trestle was designed by Mr. William W. Goodale, Manager of the estate, and built under his charge.

The trestle is 157 ft. high above the bottom of the ravine at the center. The straight bents at the side are spaced 16 ft. apart; the span at the center, between the inclined bents, is 30 ft., and the other inclined bents are 20 ft. apart at the top. The span or opening between the two central inclined bents at the bottom is 140 ft.

The framing is exceedingly simple, and the work is all done by unskilled laborers and by carpenters having no knowledge of anything but the roughest work. No heavy pieces are required to be carried over a rough country, and there are no heavy weights to be raised. In erecting this trestle a watch-tackle was used, one double and one single sheave, a spar being run out from the completed bent to hoist the pieces for the next one.

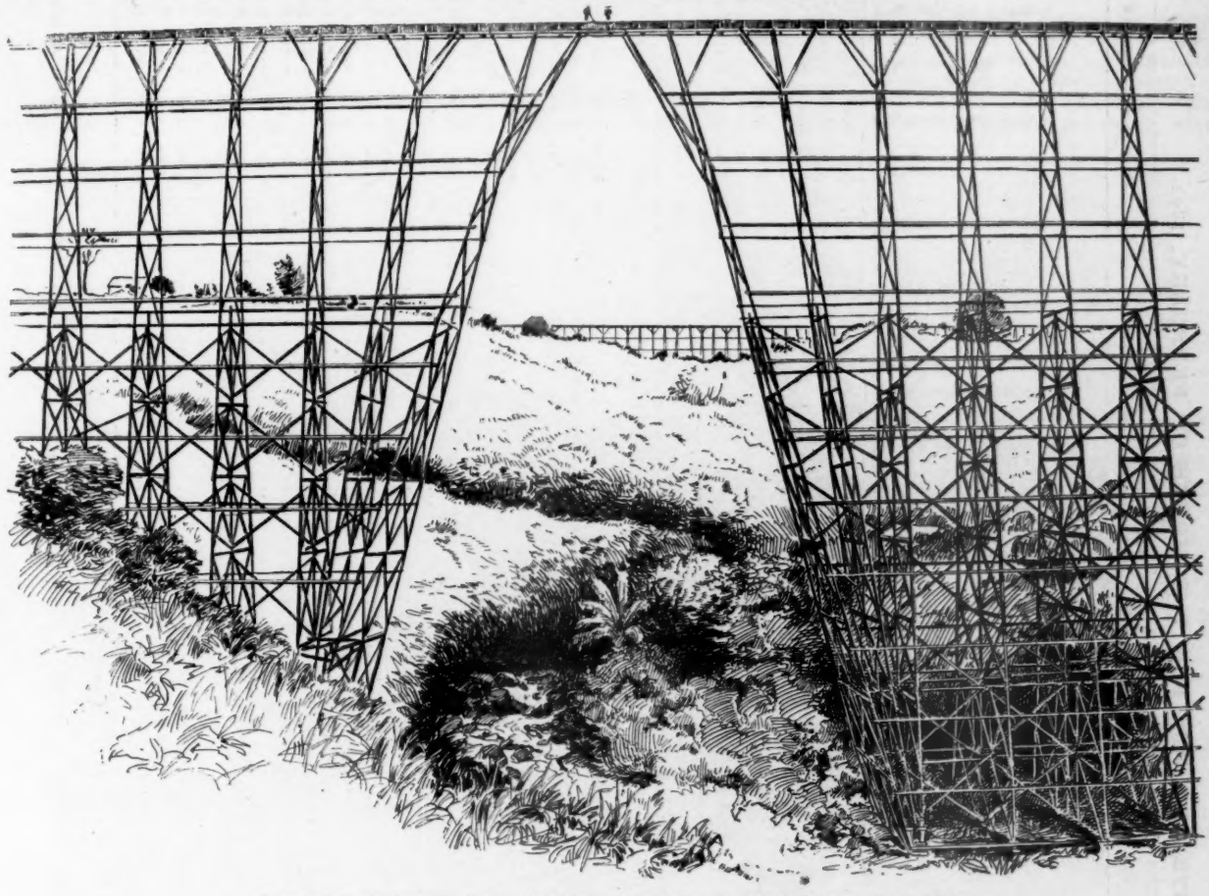
The method of framing and bracing is shown in the sketch; the highest bent, 155 ft., has a spread of 40 ft. at the ground tapering up to 3 ft. at the top. The material used is native wood; for anything up to 50 ft., 3 × 4-in. scantling. For heights from 50 to 100 ft., for the lower 40 ft. 4 × 6-in. scantling, and for the balance 3 × 4-in.

are used. For bents over 100 ft. the lower 80 ft. are of 4 × 6-in. stuff, the rest of 3 × 4-in. All longitudinal braces are of 2 × 4-in. stuff; the cross-braces are 2 × 4 in. and 2 × 3 in. The method of bracing the inclined bents and the 30-ft. center span is shown in the sketch.

The flume which is carried over the ravine on this trestle is a trough 22 in. wide at the top, 12 in. at the bottom and about 12 in. deep in section. It is made of planks, the bottom one being 12 × 1¼ in., and the two side-planks 15 × 1¼ in. It is used, like the lumber flumes of California, not only for carrying water, but for floating other material. The flume has a grade of 15 in. in 100 ft., and when running nearly full of water will deliver at the mill from 20 to 25 tons of sugar-cane per hour from a field four miles distant.

This method of trestle-building was adopted by Mr. Goodale four years ago, replacing heavy truss construction and wooden arches; it has proved very successful, serving all purposes and diminishing the cost and labor of construction very much. It seems very well adapted for the purpose and for the place, and certainly reflects credit on the designer.

It may be added that the Onomea Estate is one of the largest and most successful in the Hawaiian Islands, the output of its mill being about 7,000 tons of sugar a year.



TRESTLE-BRIDGE AT ONOMEA, HILO, HAWAIIAN ISLANDS.

THE MEMPHIS BRIDGE.

THE great bridge over the Mississippi at Memphis was opened to public use on May 12 with appropriate ceremonies. It is the first bridge to cross the river below St. Louis, and is in itself a remarkable and noteworthy structure.

It has been built chiefly to connect the Kansas City, Fort Scott & Memphis road with its southeastern extension, the Kansas City, Memphis & Birmingham, but it also has connections with the other roads entering Memphis from the east and converging opposite that city on the Arkansas side. It carries a single-track railroad line, and the entire structure is some three miles.

The bridge proper is 2,597.1 ft. long in five spans, as follows: Eastern shore span, 225.8 ft.; main span, 790.4 ft.; two river spans, each 621.1 ft.; the western shore span, 338.7 ft.

The main span of 790 ft. is the longest truss span in this country and the third longest in the world, the opening being exceeded only by the 1,710-ft. spans of the Forth Bridge in Scotland, and the 820-ft. span of the Sukkur Bridge over the Indus in India.

The bridge is of the cantilever type. The eastern shore span is the anchor arm, 225.8 ft.; the main span is made up of two cantilever arms, each 169.4 ft., and an intermediate span suspended from the arms and 451.6 ft. long; the third span is a continuous truss 621.1 ft. long; the fourth span is made up of a cantilever arm 169.4 ft. and a truss span 451.6 ft. long, one end of which rests on the cantilever arm and the other on a pier; the western shore span is a deck truss of 338.7 ft.

There are five river piers, all of masonry built up on caissons sunk by the pneumatic process. The depths to which they were sunk to reach a solid bottom vary from 78 to 131 ft. below high water.

The trusses of the long spans are 77 ft. 8 in. in depth, and some idea of their size may be drawn from the fact that the main posts of the cantilever are 80 ft. in length and weigh about 28 tons each. The superstructure is of steel.

On the eastern or Tennessee bank the land is high and the bridge meets the bluff rising from the river. The approach tracks, however, are carried through the city of Memphis on an elevated structure 2,627 ft. long, composed of plate girders of 46 ft. span. On the western or Arkansas shore the land is low, and long approaches were required. These consist of a steel trestle or viaduct 2,290

LOCOMOTIVE RETURNS FOR THE MONTH OF FEBRUARY, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	64	53	48,699	88,009	31,782	168,490	3,179	....	....	60.98	93.46	46.73	76.04	....	6.01	4.30	5.10	0.23	0.40	6.00	1.80	17.83	....	...	....
Alabama & Vicksburg	19	16	16,886	16,909	6,388	43,183	2,699	....	....	52.77	108.10	34.48	73.83	....	6.50	3.40	6.50	0.28	0.70	6.20	1.70	18.78	....	....	....
Atchison, Topeka & Santa Fé	707	591	.....	.....	297,473	1,884,990	3,189	....	....	...	....	....	83.65	....	....	6.25	6.84	0.28	0.18	6.25	1.57	21.37	....	. ..	1.55
Canadian Pacific	581	....	448,178	773,042	254,032	1,475,252	2,539	. ..	....	....	....	...	77.22	....	...	4.64	13.58	0.47	....	5 47	1.45	25.61	....	2.31	3.48
Central New England & Western	36	27	23,716	36,627	19,228	79,571	2,947	3.48	15.20	72.45	108.80	100.70	79.20	21.22	7.07	5.45	10.67	0.42	....	4.77	0.68	21.99	...	...	....
Chic., Burlington & Quincy	503	..	.....	.....	.....	1,673,856	3.328	4.71	17.58	....	....	....	90.66	....	....	4.66	6.70	0.23	0.41	6.96	....	18.96	....	....	1.46
Chic., Milwaukee, & St. Paul	805	....	.....	.....	.....	2,340,973	2,908	....	....	...	....	....	77.58	....	.	5.28	8.15	0.28	....	6.98	....	20.69	....	....	2.05
Chicago & Northwestern	846	....	618,630	1,217,457	559,659	2,395,740	2,832	....	....	....	....	....	88.69	....	. ..	3.77	8.24	0.37	....	7.15	....	19.53	....	....	1.84
Cincinnati Southern	106	92	74,299	173,606	66,046	313,951	3,413	. ..	.. .	76.33	125.00	48.90	97.66	.. .	7.46	3.40	6.40	0.26	0.60	6.60	1.60	18.86	.. .	....	....
Cleve., Cinn., Chic., & St. L	....	445	391,202	613,549	331,850	1,336,601	3,004	4.30	21.00	78.06	126.18	73.65	99.05	18.20	6.01	3.01	6.46	0.19	2.02	6.55	0.24	18.47	....	....	1.30
Cumberland & Penn	22	20	5,065	27,444	.. ..	32,509	1,625	....	....	....	....	....	90.91	....	...	8.34	5.10	0.40	...	....	2.10	15.94	....	....	....
D., L. & W., Main Line	207	197	.....	.....	... .	614,239	3,118	....	....	...	....	....	90.58	....	....	3.49	6.77	0.38	....	6.12	....	16.76	....	....	....
Morris & Essex Div.	156	....	152,694	250,879	11,393	414,966	2,660	....	....	....	....	....	64.40	....	...	3.82	10.20	0.34	....	6.42	....	20.78	....	....	3.13
Hannibal & St. Joseph	44	43	40,656	80,247	23,725	144,628	3,287	4.76	16.13	.. .	....	....	87.26	14.57	6.97	3.82	5.36	0.14	0.34	6.72	....	16.58	....	....	1.41
Kan. City, F. S. & Mem	151	...	96,098	248,048	115,750	459,896	3,045	...	....	...	....	....	68.07	....	....	3.09	5.94	0.24	0.41	7.28	....	16.96	....	....	1.63
Kan. City, Mem. & Birm	41	38	34,674	60,573	10,292	105,539	2,777	....	....	....	....	....	68.54	....	....	3.18	4.55	0.77	....	6.85	....	15.35	....	....	1.29
Kan. City, St. Jo. & Council Bluffs	45	43	56,009	43,614	36,748	136,371	3,030	4.95	19.03	....	....	....	63.35	13 93	4.51	4.72	5.25	0.13	0.11	5.38	....	15.59	....	....	2.00
Lake Shore & Mich. South	575	....	413,359	925,038	543,017	1,881,414	3,272	..	....	63.96	89.89	36.40	68.80	...	....	3.14	5.48	0.13	0.06	7.13	0.17	16.11	....	....	1.85
Louisville & Nashville	....	*363	409,832	796,399	349,450	1,555,681	3,323	5.08	15.76	64.90	116.35	52.23	86.84	12.61	6.84	4.81	7.01	0.26	1.45	6.14	0.61	20.28	3.19	1.58	1.62
Manhattan Elevated	....	282	730,492	. .....	61,503	791,995	2,808	....	.. .	...	....	....	47.73	....	....	2.10	9.70	0.30	....	8.70	...	20.80	....	...	4.03
Mexican Central†	...	....	.....	.....	....	..... .	..	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	...	....
Mil., L. S. & West	112	98	73,067	159,015	68,941	301,023	3,072	....	....	....	....	....	76.42	....	....	3.79	13.41	0.16	....	6.32	0.89	24.57	....	....	3.00
Minn., St. Paul & Sault Ste. Marie	63	57	69,591	152,739	18,157	240,487	4,219	3.42	15.48	....	....	....	77.55	....	....	4.61	13.01	0.21	....	6.53	....	24.36	...	....	....
Missouri Pacific	339	308	.....	.....	....	1,112,135	3.611	4.43	17.64	...	....	....	93.26	19.45	6.16	5.20	6.64	0.35	1.31	6.63	1.44	21.59	4.80	1.36	1.40
N. O. & Northeastern	37	29	25,699	44.454	17,415	87,568	3,020	....	....	59.52	111.73	45.15	81.63	...	5.83	2.60	7.70	0.28	0.70	6.20	1.60	19.28	....	....	....
N. Y., Lake Erie & West	....	615	411,318	1,002,058	292,778	1,706,154	2,774	4.50	20.30	92.50	134.90	73.10	...	20.50	6.50	5.00	7.40	0.40	2.72	7.28	1.11	23.91	....	1.81	1.30
N. Y., Pennsylvania & Ohio	....	265	132,987	451,182	130,853	715,022	2,698	5.10	17.30	86.70	140.20	75.70	....	17.00	8.10	5.24	7.46	0.32	2.19	6.79	1.02	23.02	....	1.94	1.25
N. Y., Prov. & Boston	....	92	101,018	48,772	55,023	204,813	2,226	...	....	....	....	....	53.28	....	....	3.09	10.61	0.51	....	6.41	0.93	21.55	....	....	...
Old Colony	....	210	293,245	119,008	102,966	515,219	2,453	..	... .	....	....	....	60.53	....	....	3.79	11.35	0.64	....	6.91	0.81	23.50	...	....	3.75
Philadelphia & Reading	....	...	419,514	795,268	528,925	1,743,707	....	....	....	....	....	....	87.22	....	....	4.74	4.79	0.33	...	5.76	0.40	16.02	...	....	...
South. Pacific, Pacific Sys	...	....	.....	..... .	..... .	. .....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....
Union Pacific	992	....	668,852	1,157,281	472,760	2,298,893	2,307	5.48	15.63	....	....	....	104.90	16.17	9.26	7.73	10.65	0.46	0.92	8.09	1.20	29 05	4.83	2.37	2.00
Vicksburg, S. & P	24	14	16,10$_4$	8,136	9,594	33,834	2,417	....	....	43.19	111.11	32.68	57.80	....	6.03	4.10	7.60	0.24	0.90	6.20	2.40	21.38	....	....	....
Wisconsin Central	156	136	122,25^8	241,239	53,582	417,079	3,067	....	....	....	....	....	88.61	....	....	3.73	11.02	0.26	....	7.34	....	22.35	.. .	...	2.44

Note.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 16.6 units of work per $1 of expense; 172.4 units of work per ton of coal; 11.6 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

ft. long ; a wooden trestle 3,097 ft.; a short embankment ; then another trestle 290 ft. long, over the Little Rock & Memphis tracks, and finally an embankment 650 ft. long.

The bridge was designed by Mr. George S. Morison as Chief Engineer and built under his supervision, Mr. Alfred Noble being Resident Engineer. The contract for the masonry was taken by L. Ross, of Rochester, N. Y. The steel and iron work of the bridge was furnished by the Union Bridge Company and the Pencoyd Works of A. & P. Roberts. The viaduct approaches were built by Cofrode & Saylor and the Pennsylvania Steel Company. All the work was done under the specifications made by the Chief Engineer, and under his supervision.

The Berry & Orton Company.

THE publication of the engraving of an excellent machine manufactured by this Company gives a good text or occasion for the publication of some notes of a recent visit to their shops.

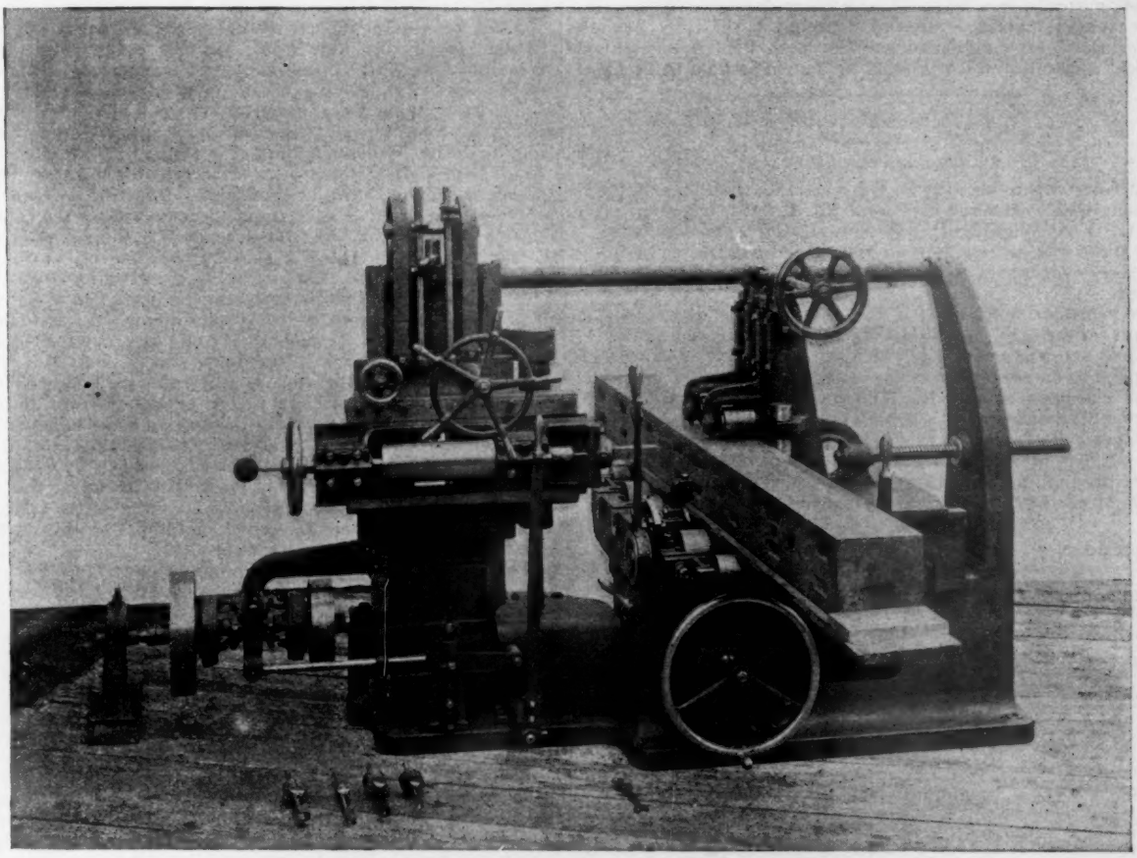
The Company is well housed in a four-story building on the corner of Twenty-third and Arch streets in Philadelphia. Its specialty is tools for working wood. Among these are band-saw machines, the manufacture of which is very interesting. The steel blades are made of Swedish steel imported specially for this purpose, and vary in thickness from No. 24 to No. 14 wire gauge and from $\frac{1}{16}$ to 12 in. in width. Some of the saws are as much as 54 ft. long. The steel when received here is properly tempered for use. The first step is to straighten the blades—that is, to take out any "kinks" that may exist. This is done by first rolling the blades and then hammering by hand. Any inequalities are detected by the reflection of light on the polished blade. The teeth are then punched out and afterward filed and set by a machine which works automatically. An ordinary three-cornered saw file is used in these machines which work in the most business-like and apparently intelligent way, and show not the slightest intention of striking for higher wages or shorter hours.

An interesting feature in the shop is the method of driving the shafting, of which there are two lines at right angles to each other on some or all of the floors. One of these lines is driven by a manilla rope consisting of 14 strands, four of which run over pulleys on each floor to drive the shafting on that floor.

The Company has provided well-appointed and comfortable offices and drawing-room, and all the floors of the shop are well lighted and warmed, and have the thrifty and prosperous appearance for which Philadelphia machine works are noted.

The engraving given is from a photograph of a hollow-chisel mortising machine made by the Company, and a comparison between it and the machines made some time ago for the same purpose will show the great advance and the many improvements secured in this class of tools.

The novelty of this machine consists of the peculiar formation of the chisel, which is square and is fitted with an auger made to revolve inside it. The end of the auger projects slightly beyond the edge of the chisel, and when presented to the timber it bores a round hole—the chisel following it and simultaneously squaring out the four corners and sides. Mortises of any length and width may be cut by forming a succession of square holes running into each other.



NEW HOLLOW CHISEL MORTISING MACHINE.
MADE BY THE BERRY & ORTON COMPANY, PHILADELPHIA.

It will be observed that with a machine of this kind the mortise is left clear of chips, and that tenoning and gaining can be done to good advantage.

The timber is clamped by friction rolls to a bed filled with heavy rollers which are driven in either direction by power or hand without releasing the clamp. This improvement increases the capacity of the machine about 50 per cent over the old way of releasing the timber and reclamping at each mortise. The oak piece shown in the engraving is designed for the end sill of a car and contains 16 mortises, which were cut without laying out in less than four minutes.

The cutting edges of the chisels are the matrix of a sphere and are readily sharpened by holding on an emery ball of the proper diameter. All machines are fitted with an arbor suitable to carry these, thereby reducing the cost of sharpening to a minimum.

The chisel is automatic in its movement or may be stopped at each stroke.

Foreign Naval Notes.

A NEW submarine boat has been designed by a Portuguese engineer, Dom Fontes Pereira de Mello, which is described as possessing several novel features. The boat has a length of 72 ft., a diameter of 11 ft. 2 in., and a displacement when submerged of 100 tons. Power is furnished by a motor working from accumulators, which drive a pair of screws and give a speed of six knots, maintainable for 14 hours.

The boat is submerged by introducing water ballast into reservoirs, and by horizontal propellers, its perfect stability under all conditions being insured by a special arrangement. When submerged, direct communication is kept up with the outer air by means of long hose, which admits of 40 cubic meters of air per hour, and allows the free respiration of natural air. The dome is furnished with an optical tube 16½ ft. long and slightly over 4 in. in diameter, within which a set of mirrors reflect the image of the object to be observed, and magnify it before it meets the eye of the observer.

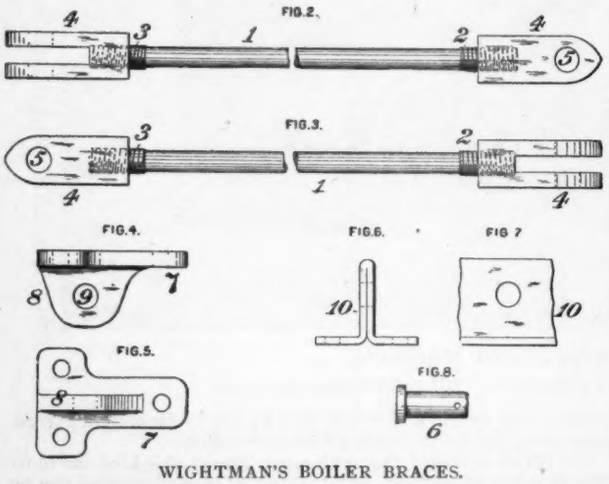
The special advantages claimed for the new boat over all others are: Its absolute stability, even when submerged in a strong current; free respiration, without the necessity for reservoirs of compressed air, and consequent ability to remain under water for lengthened periods; and, finally, the special optical apparatus which permits of a good lookout being kept.

Recent Patents.

WIGHTMAN'S BOILER BRACE.

THE accompanying drawings, figs. 2–8, show an improvement in boiler-braces covered by Patent No. 473,183, recently issued to Mr. D. A. Wightman, of Pittsburgh, Pa. The nature of the invention will be readily seen from the drawings, and the advantages over braces of the ordinary welded form will be appreciated.

In practice the ends of a rod 1, of suitable diameter and length for the service required, are upset or increased in diameter, and screw-threads 2, 3, which are preferably, as shown, of opposite lead—that is to say, right and left handed, respectively—are cut upon said ends. The heads 4 of the brace, which may be of similar form, are preferably made by drop-forging, and eyes 5 are formed in said heads to receive coupling bolts or pins 6. An internal screw-thread is cut upon each head at and near the end furthest from its eye 5, the threads of the two heads of each brace being in correspondence with those of the



WIGHTMAN'S BOILER BRACES.

ends of the rod 1 which they are designed and adapted to engage. In the instance shown the heads 4 are bifurcated, an eye being formed in each of their jaws, which are adapted to embrace a projection upon a fixed bearing-piece; but if preferred, they may have only a single tongue or plate adapted to fit between jaws on a bearing-piece. The bearing-pieces or ties by which the braces are connected to the boiler-shell and heads or ends may be of any suitable form adapted to be firmly secured to the boiler and to present a proper bearing for the reception of a connecting or coupling pin.

Figs 4 and 5 show a bearing-piece suitable for attachment to curved portions of the shell, the same consisting of a foot 7, in which are formed a proper number of rivet-holes and which has a projecting lug 8, adapted to fit freely between the jaws of a brace-head 4 and provided with an eye 9 to receive a coupling-pin 6. Figs. 6 and 7 show a bearing-piece 10 substantially of the form ordinarily used on the flat ends or heads of boilers, the same being a plate bent into T-section and provided with coupling-bolt eyes. If preferred, T-iron of proper strength may be substituted, the special form of these and of the shell bearing-pieces not forming any part of my present invention.

In practice the bearing-pieces or ties are riveted to the shell in their several desired positions by a riveting-machine while the shell is being put together, after which it is only necessary to put the braces in position, insert the coupling-pins, and draw the braces to their proper degree of tightness by turning the rods 1, and thereby screwing the heads 4 into their proper positions on the screw-threads of the rods.

It will be seen that this improved brace has no welds, and may be made altogether by machinery. In its application absolute uniformity of tension of the several braces may be secured, a result of substantial practical importance and value which is impossible with the ordinary brace, and it has been found in actual use that the entire labor on this improved brace is less than either the blacksmith's or the boiler-maker's labor on the ordinary brace.

A Car-Wheel Boring Mill.

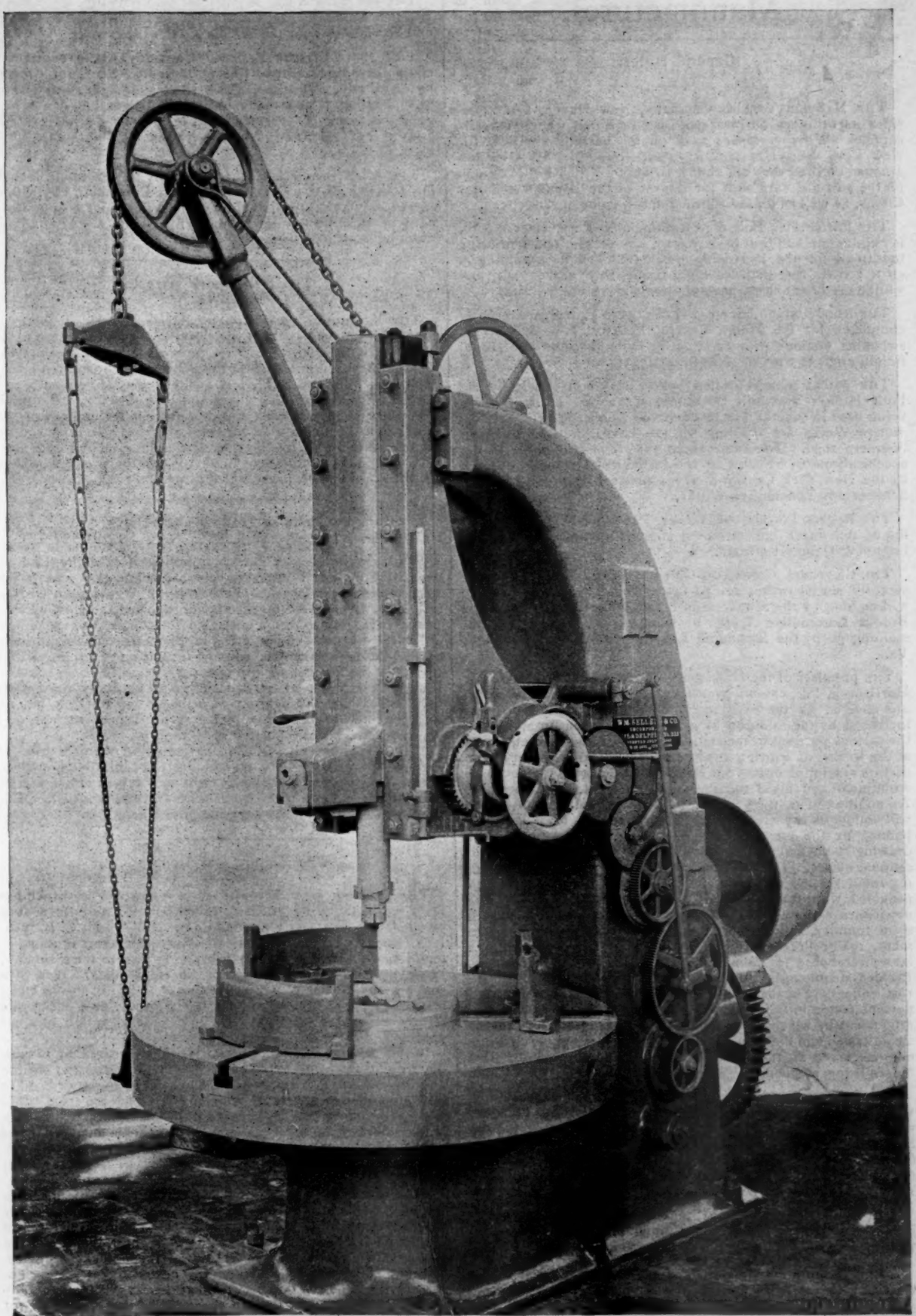
THE evolution of the car-wheel boring mill has developed in general along the same lines, and the result is a type of machine in which the products of the various makers are in the main identical, differing generally in minor features only.

The illustration given herewith is from a photograph of one of the latest machines of the class under notice, a 50-in. boring mill built by William Sellers & Company, of Philadelphia. Among the points which are peculiar to this machine may be noted, first, the *Table;* this is provided with a self-closing universal chuck—that is, starting the table causes the chuck to close upon the work and hold it securely. Stopping the table compels the chuck to open so as to release the work. The chuck has three slides, each carrying a swiveling jaw of cast steel, and each jaw has two gripping points, so that the wheel is practically held and centered by six points. Repeated stopping and starting of the table does not disarrange the work, as the jaws close each time to the same place. The table is carried upon a flat bearing ring, is centered by a hollow spindle, and is driven by a steel bevel pinion engaging with teeth upon the under surface of the table. For stopping the table a clutch arrangement is provided, by means of which the table may be stopped or started instantly and without shock by the simple movement of a hand lever. These two features, the self-closing chuck, and the instantaneous stopping of the table, are radical departures from any of the prototypes of this machine and contribute largely to increase product.

The boring bar is provided with four cutting edges, the cutters being secured in the bar by a very simple locking device, which greatly facilitates the work of changing cutters. The bar is carried on the end of a slide of large section and great length which is counterbalanced by a weight hanging in the frame of the machine. It is provided with a rapid hand adjustment and an adjustable friction feed, which will give any amount of feed required, from a fine roughing-cut to a ⅛ finishing feed. The lever for regulating the feed is provided with an automatic latch which secures it in any position, so that in adjusting the amount of feed, it is only necessary to push the lever to the point desired, as when released it will remain where placed. The friction feed is engaged and disengaged by a hand lever with a spring latch operating a toothed clutch which can be engaged in any position, thus giving positive command of the feed, so that there is no danger of the apparatus becoming jammed, as sometimes happens with devices employing friction clamps of various sorts. There is also a facing rest, for the ends of hubs, situated on the end of the slide, which is brought into position for cutting after the boring cutters pass through the wheel.

Another feature of this machine is the crane attachment. This is driven by friction gearing within the machine, and holds the load automatically suspended at any point. It is also arranged to stop automatically when the top or bottom of the lift is reached. The operator, when putting a wheel in place, starts the hoist with one hand and then uses both hands to steady the wheel. When the top of the hoist is reached the crane stops. The wheel is then swung into position and a reverse movement of the handle starts it to lowering, while the operator has both hands free to guide the wheel into the chuck. The handles for controlling the machine are all gathered together in one place, where they can be conveniently reached by the operator as he stands directly in front of the machine.

The table is 50 in. in diameter and the chuck will take a 42-in. wheel. There are two speeds for the countershaft and the gearing is exceptionally powerful. The machine may be considered the latest development of its class, with all the improvements which experience has shown to be desirable.



50-INCH CAR-WHEEL BORING MILL.
MADE BY WILLIAM SELLERS & COMPANY, PHILADELPHIA.

Manufactures.

General Notes.

THE National Varnish Company, New Haven, Conn., besides its ordinary business with carriage and wagon makers, supplies all the varnishes used on the passenger cars of the New York, New Haven & Hartford Railroad. Its varnishes are also used on the cars of the Brighton Beach Railroad, and on the railroad cars built for the use of the Barnum & Bailey Circus, as well as on the chariots and wagons of that circus.

THE Portchester Bolt & Nut Company, Portchester, N. Y., is building an addition to its works, the present quarters being too small for the increasing business. The new building is 50 × 100 ft., three stories high, frame, with gravel roof, and will be used for offices, packing-rooms and storage-rooms.

THE Rhode Island Locomotive Works in Providence recently completed for the Maine Central Railroad two six-wheeled switching engines with 18 × 24-in. cylinders, and two Mogul freight engines with 19 × 24-in. cylinders.

THE patent mandrel-rolled hollow stay-bolts made by the Falls Hollow Stay-bolt Company, Cuyahoga Falls, O., are being used in several new locomotives which the Brooks Locomotive Works are building for the Lake Shore & Michigan Southern road. The same stay-bolts are also required by the specifications to be used in 100 locomotives recently ordered by the New York Central & Hudson River Railroad from the Schenectady Locomotive Works.

THE Rogers Locomotive Works, Paterson, N. J., are building 25 ten-wheel and 25 mogul engines for the Chicago, Burlington & Quincy Railroad.

THE Cleveland, Columbus, Cincinnati & St. Louis Company recently placed orders for 50 new locomotives. Of these 10 will be built by the Schenectady Locomotive Works; 10 by the Brooks Locomotive Works at Dunkirk, N. Y.; and the remaining 30 by the Richmond Locomotive Works, Richmond, Va.

THE premises of the Harrisburg Foundry & Machine Works, Harrisburg, Pa., extend over about 22 acres, 6 acres of which are covered by the existing buildings, which will shortly be increased by the addition of a large warehouse for storage of the various portions of the standard sized engines manufactured at the works, of which a considerable stock will be carried, so that on receipt of orders for engines the different parts can be withdrawn and fitted together with the least possible delay. An addition of 90 ft. is also to be made to the foundry, which will double its capacity. The offices have also been lately expanded by the erection of a new wing, which enlarges the drawing-room and provides a directors' room and several additional offices. The directors' room is thrown open as a reading-room for the employés out of working hours, and is well provided with trade journals and other publications. The departments in the works are two machine shops, a pattern shop, foundry, smith shop, boiler shops, wood-working department, road-roller department, grinding shop, testing shop, a large warehouse for finished goods and a pattern storehouse. Besides steam-engines and boilers, a large number of steam road-rollers are made. The testing department is a most important factor in the works, and is fitted with an excellent arrangement by which any number of engines up to eight can be steam tested simultaneously to any required pressure. All the engines made are fitted together here, and thoroughly tried before being shipped.

THE Pullman Car Works, Pullman, Ill., have a great deal of work on hand, including 100 passenger cars for the Philadelphia & Reading; 25 for the Norfolk & Western; 22 for the Southern Pacific; 20 for the Chicago, Rock Island & Pacific; 6 parlor cars for the Chicago & Northwestern, and a number of smaller orders. The freight shops are building 400 coal and 1,000 box-cars for the Norfolk & Western Railroad.

THE United States Rolling Stock Company will be reorganized as the United States Car Company. The new concern will issue $3,500,000 stock and $4,000,000 bonds.

AT the recent annual meeting of the American Steel Wheel Company, Mr. J. H. Olhausen was elected Vice-President, and Mr. Samuel Garwood, Secretary and Treasurer. It was also decided to remove the Secretary and Treasurer's office from Boston to the general offices of the Company, New York City.

THE Mt. Vernon Car Manufacturing Company, Mt. Vernon, Ill., is building 300 flat cars for the Evansville & Terre Haute and 200 box-cars for the Mobile & Ohio Railroad.

THE Short Electric Railroad Company has a contract to equip the street railroad line at Bangkok, Siam, for working by electricity. The line, which is of 30-in. gauge and about 6½ miles long, is now operated by mule power and does a very good business. The electric plant includes an engine, two generators of 65 H.P. each and six cars with motors of 20 H.P. each.

THE Jones Brothers Electric Company in Cincinnati is making a model 20 × 50 ft. in size for the Columbian Exposition. It will show the extensive plant of the Frick Coal & Coke Company in Western Pennsylvania, with trains, engines, etc., in motion; it will be worked by electricity.

The Bell Spark Arrester.

THE locomotive spark arrester devised by Mr. J. Snowden Bell, of Pittsburgh—which was described and illustrated in the JOURNAL for March, 1890—has, we are informed, recently had a careful test on an engine of the Wisconsin Central road, with such favorable results that it has just been fitted on a new 19 × 24-in. cylinder Mogul engine for further use. A number are in use on the Mexican Central, and all the engines of that road are to be fitted with Mr. Bell's device. It is also in use on the Southern Pacific lines, several engines having been fitted up at the Sacramento shops, and it is shortly to receive a thorough test on the Pennsylvania Railroad.

Tests of Hollow Stay-Bolts.

SOME specimens of hollow stay-bolt iron made by the Falls Hollow Stay-bolt Company, Cuyahoga Falls, O., have just been tested at the Physical Laboratory of Washington University in St. Louis, and the results are reported as below by Professor J. B. Johnson:

"Size of tested section, 0.895 in. diameter and 10½ in. long, with $\frac{3}{16}$-in. hole at center; area of section, 0.601 sq. in. Broke at 29,600 lbs.; breaking strength per square inch, 49,200 lbs.; limit of elasticity, 17,000 lbs.; limit of elasticity per square inch, 28,300 lbs.; elongation of reduced section in 5 in., 1.7 in.; per cent. of elongation, 34; area of reduced section, 0.30 sq. in.; per cent. of reduction in section, 50.

"This is a remarkably fine specimen of wrought iron for stay-bolt purposes. Its elongation, 34 per cent., is the greatest I have ever found for wrought iron, and this is of the utmost importance in stay-bolt iron. The fracture shows a pure, fibrous, unlaminated and uncrystalline structure."

The Empire Car Coupler.

THE drawings given herewith show a new coupler which has been worked out by practical railroad men, and which, it is claimed, fills completely the requirements of the M. C. B. type. It is also claimed that it meets all the requirements of an automatic safety coupler, entirely preventing risk to the trainman. In the drawings figs. 1 and 2 show an elevation and plan of a coupler; fig. 3 is a section on the line *A C*, fig. 2; figs. 4 and 5 show the coupler in section; fig. 6 is a front view; figs. 7 and 8 show respectively an end view and a side elevation of a car provided with the coupler.

In this coupler extraordinary strength is secured by providing from 5 sq. in. to 6 sq. in. of locking surface, and by the knuckle engaging with the side and end of the draw-head in such a manner as to almost entirely relieve the pin from either buffing or pulling strains. Under this construction a small pin is used, allowing for more material in the knuckle and the jaws of the draw-head. The draw-bars will be manufactured from the best quality of malleable iron, and the knuckles from a grade of steel which has earned a high reputation in such work.

Next to strength it is required for a coupler that the mechanism must be such as will not get out of order, and can be easily operated under all conditions of the freight train service. The Empire coupler proper is composed of but three parts, the knuckle-opening device being a part of the unlocking device. The unlocking and knuckle-opening device is completely enclosed within the shell of the draw-bar, and is protected thereby from the elements and foreign substances; it is impossible for this coupler to freeze up. On account of the increased leverage provided for unlocking, it is believed that it will never be necessary to take slack for uncoupling. It is claimed that the

coupler can be uncoupled under a greater strain than any one yet introduced, which is an important consideration in the switching service of a large yard.

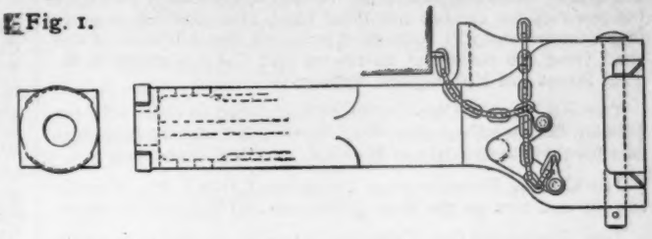
The draw-bar of the M. C. B. type of coupler being so large that the safety of the train is imperiled in case it should be dropped upon the track through the breakage of a tail-pin or the snapping off of the head, provision should be made against such contingencies. This has been accomplished in this coupler by a chain attached to the unlocking device and the end sill of the car, so that when the draw-bar should be moved forward after breakage of the tail-pin the knuckle will be unlocked. Or, if the head of the draw-bar should be broken off, the same chain, together with the chain attached to the unlocking lever, will prevent it from dropping to the track.

It is well understood by the operating officials that one great cause of damage to car equipment is the failure of men to be on top to apply the brakes when switching. Cars are uncoupled from the ground and kicked into sidings, and before men can climb to the top to set the brakes collisions occur with other cars and damage results. Therefore, a coupler, to fully meet the requirements of the service, must be of such design that it can be operated from the top of the car as well as from the ground, so that the brakemen will be in position to set the brakes immediately when necessary. This coupler meets this requirement, since it can be operated from the top of either side of the car with equal facility.

The above are the essential features of any car coupler viewed from an operating standpoint; but the M. C. B. coupler must be even more than this. It must be an *automatic safety* coupler under all conditions of service. Safety requires that men should never go between the cars to couple or uncouple them, or to put the coupler in position for coupling, under any circumstances. A careful examination of the drawings herewith will show how far the coupler will bear out the claim that it is a positively automatic safety device, meeting all the requirements of actual service.

Full-size couplers set up in working order can be seen at the office of the Empire Car Coupler Company, 15 Warren Street, New York City.

Fig. 1.



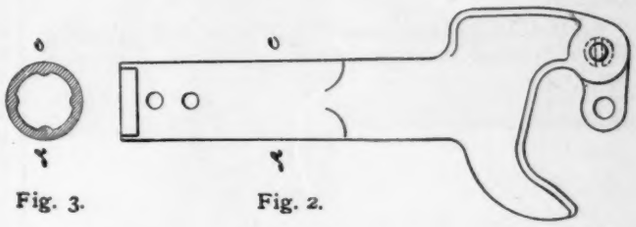


Fig. 3. Fig. 2.

Fig. 4.

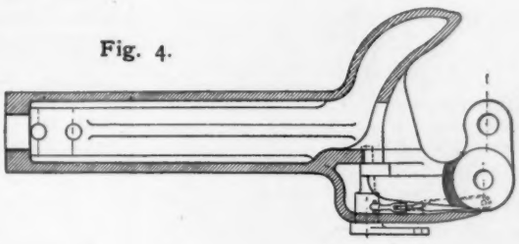
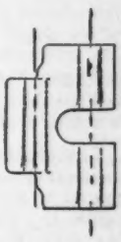


Fig. 6.



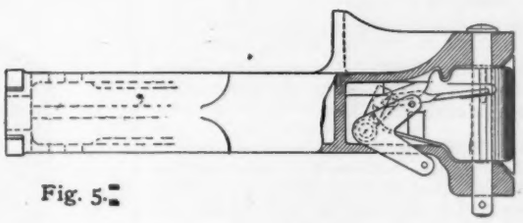


Fig. 5.

Baltimore Notes.

CONTRACTS have been awarded to the Campbell-Zell Company, of Canton, for boilers to be placed in the power-houses of the City Passenger Railroad on Baltimore and Eutaw streets, to serve the cables of the Red and White Lines. The contracts for the wheel range for the cables were awarded to the Pennsylvania Steel Company, at Steelton. President Bowie says the work of cabling these lines will now progress rapidly. He attributes much of the set-backs to the fact that the work was commenced on Friday. President Bowie does not admit that he is superstitious, but says that he would never begin any work on Friday. E. B. Smith & Company, the contractors for

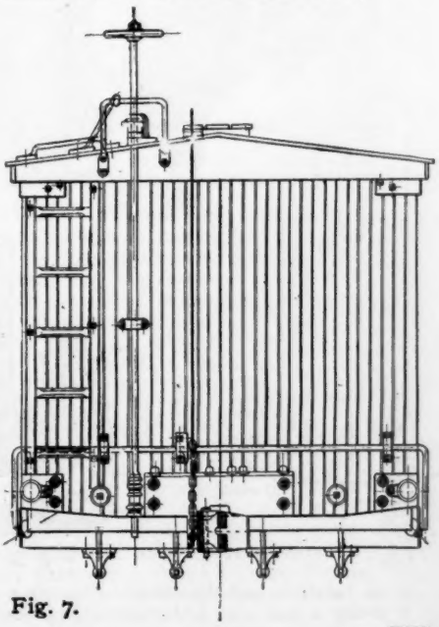


Fig. 7.

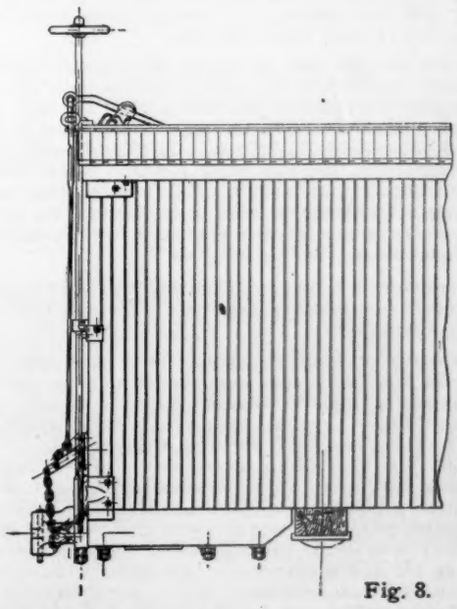


Fig. 8.

THE EMPIRE CAR COUPLER.

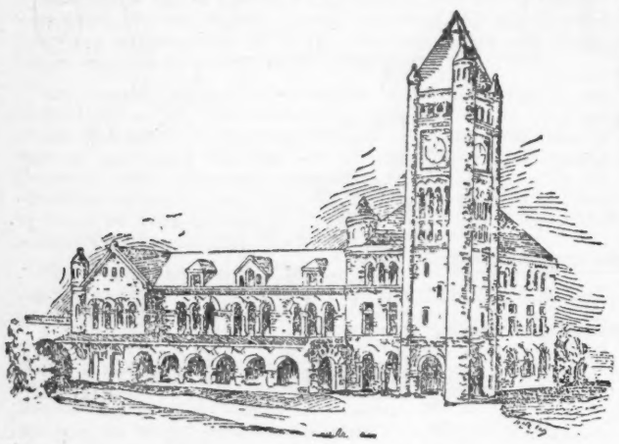
this work, agreed to begin on March 1, which was Tuesday. They encountered some delays and did not get to work until the Friday following, March 4. Saxton & Company, who have the contract for cabling the Blue Line, have opened an office in Baltimore and will soon start in on the north branch of this road, from the corner of Baltimore and Calvert streets to St. Paul Street and Huntingdon Avenue.

THE Baltimore & Ohio Company has placed an order with the Jackson & Sharp Company, Wilmington, Del., for 24 passenger cars for their Staten Island Division, to be delivered July 1.

THE Carlisle Manufacturing Company, Carlisle, Pa., is building 100 coal cars for the West Fairmont Coal & Coke Company.

THE Peninsular Car Company, Detroit, Mich., is building 200 double-hopper gondola cars for the Montana Coal & Coke Company.

THE little sketch given herewith is from the architect's design for the proposed passenger station of the Belt Railroad in



BELT RAILROAD STATION IN BALTIMORE.

Baltimore. It shows a building of brick, with stone trimmings, and the design, the leading features of which are well shown, is a very symmetrical and pleasing one.

THE Montague & Lea Machine Tool Company has been incorporated under the laws of West Virginia, with an authorized capital of $100,000. The incorporators are William L. Montague, Jr., Edward S. Lea and T. A. Dukehart, of Baltimore; Major H. W. Hunter and J. G. Coole, of West Virginia. The company will erect extensive shops and foundry at Moundsville, W. Va., 11 miles from Wheeling.

THE new tin-plate mill of Coates & Company, which has been under construction for several months past, and which has been given a number of preliminary trials, has been opened in earnest. The tin used in the past weeks was a portion of the first tin discovered in America. It came from California, and is regarded by some as being superior to the Welsh tin. Dr. L. R. Coates is the senior member of the firm and Mr. John Davis, a Welshman, is the Superintendent of the mechanical part of the enterprise, and they now have in hand large orders from Chicago, Boston and New York.

THE Baltimore & Ohio has given orders for the construction of 20 standard four-wheel caboose cars. The cars will be built at the Mt. Clare shops.

THE Sparrow's Point Steel Works have been awarded the contract for building a new steel clipper ship for one of the largest exporting firms in Boston, Mass., to be used in the trade with China. Captain Charles H. Nelson represents the Boston firm, and has much pleasure in the idea of giving to Boston her first steel bark. The vessel is to be a handsome clipper bark 220 ft. long, 39 ft. extreme beam, 24 ft. depth of hold, and of a tonnage of 1,500 net. Her hull, lower masts and topmasts, lower and topsail yards and bowsprit and jib-boom are to be of steel. She will have a full poop with wheel-house way aft, and a charthouse just abaft the mizzenmast. Forward on the spar-deck there will be a commodious house containing the galley and stores and quarters for the crew. Quarters to accommodate four boys are also provided here entirely separate from the crew—a provision which Captain Nelson believes will encourage American parents to send their boys to sea. She will be equipped with large engines for sail and windlass, and have a magnificently fitted cabin that will permit carrying a number of first-class passengers if necessary. Work will be begun at once.

THE Baltimore & Ohio Company will have its Grafton & Greenbrier Branch widened and ready for the West Virginia Central & Pittsburgh trains to run over it on about May 20. The West Virginia Central has its line all in order from Elkins to Bealington. The company has been assured by the Baltimore & Ohio that the Morgantown Branch to Uniontown will be ready in October. When these lines are completed the West Virginia Central will be in splendid shape for shipping its freight to the West and Northwest, and by its connection with the Pennsylvania System will have the option of using the roads of the two big systems to put its coal and coke upon the lakes.

THE Baltimore & Ohio Railroad Company will have its State Line Railroad finished very soon. This new line is being rapidly completed, and Smithfield, which lies 9 miles from Uniontown, will have communication by June 1. The entire line will be finished by next spring, which will open up the rich and fertile country along the Cheat River to Morgantown; it will connect with the road already in operation between that point and Fairmont, where it meets the Main Line of the Baltimore & Ohio. The present distance from Pittsburgh to Cumberland is 150 miles, but by the building of the State Line route it is only 126 miles as surveyed. The engineer does not think that passenger traffic will decrease on the picturesque Baltimore & Ohio in Winter, but when the new road is in full operation, summer excursionists will prefer it to the old one on account of the vast number of camping clubs which visit the banks of the Cheat River. Several hundred go up there every summer. As a freight thoroughfare the State Line will be preferable on account of the difference in distance to Cumberland, while it will give the Baltimore & Ohio double facilities to expedite matters in that direction.

The Norton Compound Jack.

THE cuts herewith show a new form of jack, which combines the use of the lever and screw, and has several points of excel-

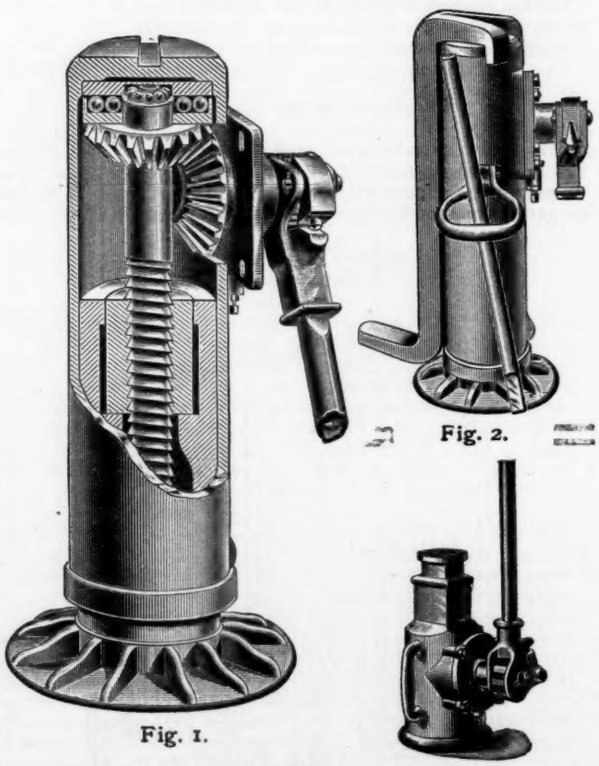


Fig. 1.

Fig. 2.

Fig. 3.

NORTON COMPOUND JACK.

lence for use on railroads and elsewhere. Fig. 1 is a sectional view; fig. 2 shows a jack with additional lifting hook; fig. 3 shows a jack made especially for the use of car inspectors. Figs. 2 and 3 are on a smaller scale than fig. 1.

These jacks are screw-jacks operated with a ratchet lever having the up-and-down or pump-handle motion, which is found very convenient in the hydraulic jack. They have a patent

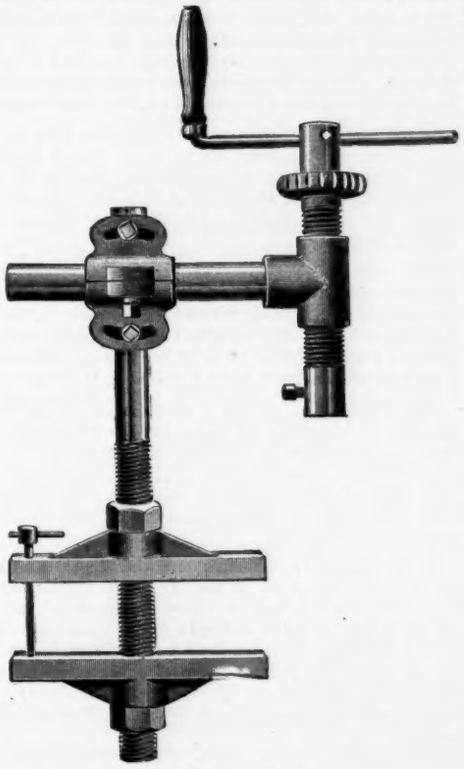
safety stop motion, preventing injury to jack or load by running the screw out of the nut. They are provided with a ball bearing, shown in fig. 1, which reduces the friction very much and prevents seizing, cutting and grinding. The screw is completely covered in, thus preventing corrosion, to which the screw of an ordinary jack is peculiarly subject, as those who have occasion to use such an appliance know very well.

The lifting hook shown in fig. 2 is a very convenient attachment; with it the jack can take hold of a load close to the ground, in cases where it would often be necessary without it to dig a hole for the jack to stand in. The use of the car inspector's jack, shown in fig. 3, will be readily understood.

Some of the advantages of this device are noted above; the claims made for it may be shortly summed up by saying that it is simple, durable and cheap, and can be applied for almost every purpose. These jacks are made by Mr. A. O. Norton, of Boston, and have met thus far with much approval.

A Useful Small Tool.

THE illustration herewith shows a clamp-drill, a tool which will be found useful in almost every machine shop, especially



BURNHAM'S CLAMP DRILL.

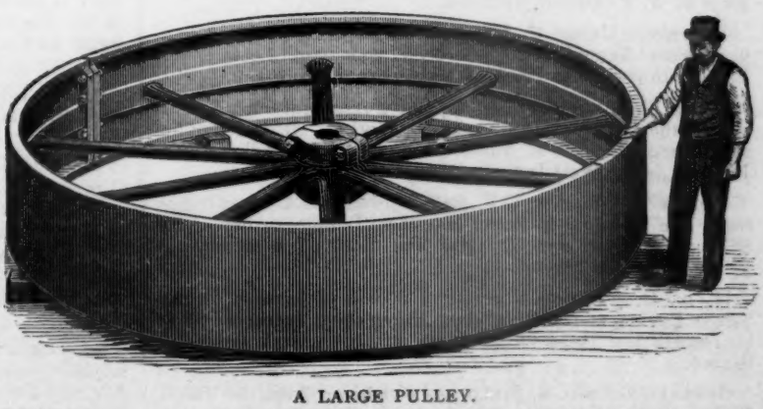
in repair shops. The one shown seems to be a well-made tool, and as light as it can be made, consistent with proper strength. Its construction will be readily seen from the engraving. It has one advantage over others of the same kind, in the arrangement of the slots and set-screws at *a a*, by which the operator can square his drill with the work regardless of the position of the clamps. The drill has the usual feed arrangement.

This tool is made by the firm of George Burnham & Company, Worcester, Mass.; it is made in several sizes, the largest being able to drill a 1-in. hole 4 in. deep. The posts are of steel, the clamps of cast steel and the swivel motion malleable iron.

The drill shown in the engraving is one of the smaller size, drilling only up to a $\frac{5}{8}$-in. hole. The larger sizes are provided with gearing to increase the speed, as in the ordinary drill.

A Large Pulley.

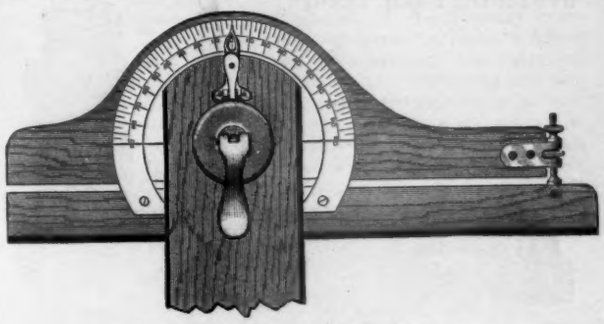
THE cut given herewith shows a pulley recently cast and finished at the foundry of L. H. Goodnow in Fitchburg, Mass. The man in the engraving is introduced to give some idea of the comparative size. This pulley is 18 ft. in diameter and 48 in. face; it was cast in two halves, and weighs 18 tons. Pulleys up to 20 ft. diameter have been made in the establishment named.



A LARGE PULLEY.

An Adjustable T-square.

ALMOST every draftsman will at once appreciate the advantages of a T-square which can be quickly and certainly adjusted



DEANE'S ADJUSTABLE T-SQUARE.

to any required angle, and which contains within itself the means of ascertaining that angle. Such a device is shown in the accompanying illustration; it is the invention of Mr. E. L. Deane, of Holyoke, Mass.

The head has, as will be seen, an inner bar, which bears against the edge of the drawing-board, and an outer bar or head, to which the blade is attached. A protractor is fastened on the inner bar, and a pointer on the outer bar indicates the angle at which the blade is set. The two bars are connected by a pivot at the center of the protractor; this is not shown in the engraving, being covered up by the hand-lever, which has a cam at the end serving to clamp the outer head in place and prevent it from moving. It is released by simply raising this small hand-lever. A further connection is made by the screw and thumb-nut at the end of the long arm of the outer bar, which serves to adjust the relative positions of the two bars. Another thumb-nut and screw on the under side of the central pivot serves to adjust the connection, so that the locking cam will have the proper bearing.

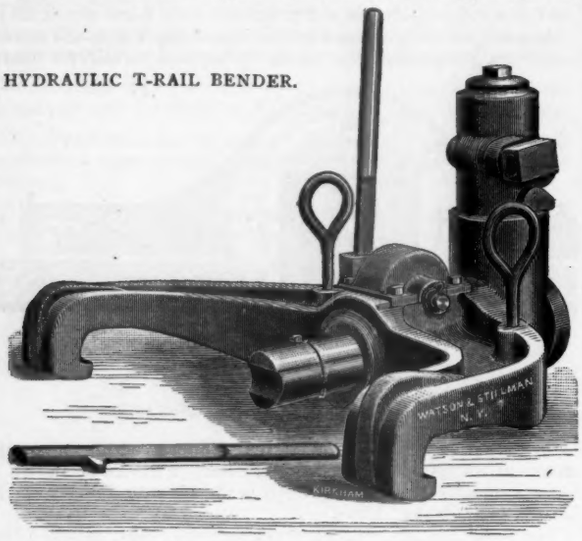
The use of the protractor and the arrangement of the parts will be readily understood from the engraving. It will be seen that the device is really a simple one, and that the blade can be readily given the smallest or a greater adjustment, and provision can be made for the differences in a board which is not exactly square—often a great convenience.

The Hydraulic Rail Bender.

THE various forms of screw rail-benders have not altogether given satisfaction with heavy rails, and they also require a considerable gang of men to handle them. The accompanying engraving shows a hydraulic rail-bender which will, it is claimed, obviate the objections made to the screw benders. Careful experiments have shown that it was not the method of bending, but the long spacing which sprung the rail up, so that a very heavy hook to catch the web was not necessary. In this

tool the ram may be run in and out without pumping for a distance of 3½ in. This allows the tool to be placed over the rail and the ram brought up to its work on the rail-head, when a few strokes will bend the rail to the desired curvature; it may then be slid along easily and another pressure given. The ram is graduated to show the spring of rail, and has a loose steel head which fits the rail-head which is being bent. In a

HYDRAULIC T-RAIL BENDER.



recent test in service two men bent 40 steel rails 30 ft. long, 90 lbs. to the yard, in one day, where previously 20 had been the best work of six men with best of screw benders, and one rail was bent perfectly flat on 45 ft. radius in 1½ minutes, on 16 in. centers of application.

This tool can be worked by one operator. The No. 4 size, shown in the engraving, weighs 275 lbs. They are made by the well-known firm of Watson & Stillman, of New York, and have just been placed on the market.

PERSONALS.

C. F. KOHLMAN has been appointed City Engineer of Racine, Wis.

J. A. MCNICOL has been appointed Engineer and Manager of the Hamilton Bridge Company at Hamilton, Ont.

CHARLES FRANCIS has been appointed Chairman and Supervising Engineer of the Board of Public Works of Davenport, Ia.

GEORGE B. CORNELL, recently Engineer of the Cornell Iron Works in New York, has been appointed Chief Engineer of the East River Bridge Company.

S. M. RODGERS, for some time past with the Pittsburgh & Western Railroad, is now Chemist of the Harnesworth Steel Company, in Pittsburgh, Pa.

S. HIGGINS has been appointed Assistant Superintendent of Motive Power of the New York, Lake Erie & Western in place of W. F. Turrell, deceased.

PROFESSOR HENRY C. ADAMS, Statistician of the Inter-State Commerce Commission, has been appointed Lecturer on Finance in the Johns Hopkins University in Baltimore.

JAMES E. SAGUE has been appointed Assistant Superintendent of the Schenectady Locomotive Works. He has been for some time Mechanical Superintendent of the railroads in Jamaica, in the West Indies.

GEORGE S. MORISON, C.E., has removed his Chicago office from The Rookery to Room 800, The Temple, corner of La Salle and Monroe streets. His New York office remains at 35 Wall Street as heretofore.

H. DE B. PARSONS is giving a course of lectures on the Steam Engine at the Rensselaer Polytechnic Institute. The course will last three months, two lectures a week being delivered.

GENERAL GEORGE S. FIELD has withdrawn from the Union Bridge Company, and purposes giving his entire time to his duties as Chairman of the Board of Public Works of the city of Buffalo.

C. A. THOMPSON has been appointed Superintendent of Motive Power of the Central Railroad of New Jersey. He was for a number of years in the same position on the Long Island Railroad.

EPES RANDOLPH has been appointed Chief Engineer of the Newport News & Mississippi Valley Company's Western Division. C. T. SABIN is now Engineer of Bridges and Buildings of the same division.

GENERAL V. E. MCBEE, for some time past General Superintendent of the Central Railroad of Georgia, has resigned that position, and it is said he has been offered an important position on the Lake Shore road.

THOMAS ALDCORN has resigned his position as Division Master Mechanic of the West Shore Railroad to accept the position of Mechanical Superintendent of the Empire Car Coupler Company, with office at 15 Warren Street, New York.

PROFESSOR MANSFIELD MERRIMAN, now of the Lehigh University at Bethlehem, Pa., has been offered the position of Professor of Mathematics in the Chicago University. Professor Merriman is well known as an author and as a high authority in his department.

COLONEL WILLIAM G. RICE, Vice-President of the Consolidated Car Heating Company, has just returned to Albany from a short trip abroad. During this trip he has carefully studied English railroad methods, and some of his impressions have been published in an interesting interview in the Albany *Argus*.

A. E. MITCHELL has been appointed Superintendent of Motive Power of the New York, Lake Erie & Western Railroad, with office in New York, succeeding the late Ross Kells. Mr. Mitchell has been Mechanical Engineer of the road for some time. He is also appointed to the same position on the Chicago & Erie Railroad.

WALTER KATTÉ, GEORGE BIRDSALL, J. B. HASKIN, C. W. DAYTON and JOHN FOX compose the commission in charge of the raising of the bridges over the Harlem River and the tracks leading thereto. Mr. Birdsall is Chief Engineer of the Department of Public Works of New York, and Colonel Katté is Chief Engineer of the New York Central & Hudson River Railroad.

THEODORE N. ELY, for a number of years General Superintendent of Motive Power of the Pennsylvania Railroad, has been promoted to be Fourth Vice-President of the Company, with office in Philadelphia. His successor as General Superintendent of Motive Power is F. D. CASANAVE, who has for some time held the same position for the Pennsylvania Company at Fort Wayne.

JOHN A. GRANT has resigned his position as Vice-President and General Manager of the Texas & Pacific Railroad. Captain Grant has served as Chief Engineer of the Port Royal & Augusta and of the Northeastern of Georgia; as Superintendent of the Macon & Brunswick; as Chief Engineer and Superintendent of the Newport News & Mississippi Valley, of the Memphis & Charleston and of the Louisville, New Orleans & Texas, and has been on the Texas & Pacific for several years past.

OBITUARIES.

ERASTUS O. HILL, for many years connected with the New York, Lake Erie & Western Railroad—last as Superintendent of the Eastern Division—died April 29 at Matamoros, Pa., where he had resided for some years.

CLARK JOHNSTON, who died in Rochester, N. Y., April 25, aged 69 years, was well known as an engineer and a railroad contractor. He built several sections of the Wabash Railroad, and held large contracts on other Western lines.

O. L. SPENCER, who died in Joliet, Ill., April 27, had many years' experience as a rolling-mill manager and was well known among iron men. He had been for some time Superintendent of the mill at Joliet, where he introduced a number of improvements in the plant.

SIR JAMES JOSEPH ALLPORT, who died recently at the age of 81 years, was one of the best known and most progressive of English railroad men. He had been a director of the Midland Railway for nearly 30 years, and General Manager of that line for a number of years past; recently he was made Chairman of the Board.

THEODORE L. WOODRUFF was killed by a train while crossing the West Jersey tracks at Gloucester, N. J., on May 2; he was 81 years old. Mr. Woodruff built one of the earliest sleeping cars, which was put in use on the St. Louis, Alton & Terre Haute Railroad about 1857, and very soon afterward he took out a patent on his car. The Woodruff sleepers have been used on various roads, but never reached the success attained by the Pullman and Wagner cars, chiefly on account of lack of capital and business method.

WILLIAM P. SHINN, who died in Pittsburgh, May 2, aged 57 years, was born in Burlington, N. J., and began work as a civil engineer at an early age. After some time spent as an assistant in county surveys in New England, he entered the service of the old Ohio & Pennsylvania—afterward the Pittsburgh, Fort Wayne & Chicago—Railroad as a rodman. He was rapidly promoted to be Assistant Engineer in charge of a division, and some 80 miles of the road were located and built under his supervision. In 1855 he was transferred to the traffic department, and for a number of years held responsible positions in charge of freight and passenger traffic. When the Pennsylvania Company was organized, Mr. Shinn was appointed as an expert to examine the affairs and conditions of the various companies interested in the leases to that Company. From May, 1871, to May, 1873, he had charge of the construction of the Ashtabula, Youngstown & Pittsburgh Railroad, and in 1873 he became President of that road. In 1874 he was Vice-President of the Allegheny Valley Company, and did some notable work in connection with the tangled accounts of that company.

From January, 1873, to October, 1879, Mr. Shinn was the managing partner of Carnegie, McCandless & Company, and had charge of the building and operating of the Edgar Thomson Steel Works. In 1879–80 he reorganized the Vulcan Steel Company, of St. Louis, and rebuilt and started those works. From 1881 to 1887 he was Vice-President of the New York Steam Company, for the distribution of heat by steam through the streets of New York. From December, 1886, to December, 1889, he was Vice-President in responsible charge of the New York & New England Railroad, and in 1888–89 he was President of the Norwich & New York Transportation Company.

Mr. Shinn was elected a member of the American Society of Civil Engineers September 15, 1869, and January 15, 1890, he was made its President. In 1875 he was elected a member of the Institute of Mining Engineers. In 1876 and 1877 he was one of its Vice-Presidents, and in 1880 he was elected President. He was an active member of both societies and contributed some valuable papers to their *Transactions*.

Mr. Shinn's last days were clouded by ill health and by the loss of his wife, to whom he was very tenderly attached, and his death was not unexpected.

Perhaps his strongest characteristic was thoroughness. Always a hard worker, he devoted himself to the task at hand, and spared no trouble or pains to complete it. He was a close and careful student of traffic problems during his railroad service, and few men understood them better than he did. Very few, also, would work as he did, on the Allegheny Valley and afterward on the New York & New England, under most discouraging conditions, intent only on doing his best, no matter what the result to himself. Such men are rare, and the places they leave are not easily filled.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting, April 20, there was a discussion on the preliminary report of the Committee on Uniform Methods of Tests. Mr. H. B. Seaman, one of the Committee, made a brief statement of the purposes of the report, and the discussion was continued by Messrs. Morison, Buck, Henning, Bush and others.

AT the regular meeting in New York, May 4, the Secretary announced that the Board of Directors had voted to take charge of the departmen of Civil Engineering at the Congress of Engineers to be held during the Columbian Exposition.

The first paper of the evening was a discussion presented by C. C. Babb, and read, in his absence, by the Secretary, on the Hydrography of the Potomac Basin. A second paper was read by A. H. Dunham, on a New Method of Tunnel Alignment. Mr. Dunham used a fixed transit station outside the portal of the tunnel, and a fixed back-sight, sighting into the tunnel at a plummet lamp suspended from a bracket held against one of the wall plates. There was a short discussion on this paper.

The chair announced the election of the following *Members:* Charles Francis, Michael L. Lynch, Otto von Geldern and M. E. Yeatman. *Associate Members:* W. A. Aycrigg, R. A. Cummings, Frans Engström, Janon Fisher, Louis Focht, A. S. Going, J. E. Hill, J. J. L. Houston, J. M. Porter, Joseph Strachan, W. L. Webb, H. R. Wheeler. *Associates:* Clarence B. Marriot, L. B. Bonnett, Oscar Lowinson, W. B. Martin, L. G. Montony, W. H. Polk, Julius Price, W. B. Yeareance.

American Institute of Mining Engineers.—The sixty-second meeting of the Institute will be held in the Lake Champlain region, beginning at Plattsburgh, N. Y., Tuesday evening, June 21. Arrangements are in progress for visits to mines and furnaces, and a trip into the Adirondacks. Contributions to the discussion of magnetic iron-ore concentrations and also of crushers, granulators and pulverizers are especially invited.

A special circular has been issued to members and associates upon the Columbian Exposition fund for an engineering headquarters. The Council desires to contribute for the Institute $4,000 toward the international headquarters, and subscriptions are asked, the sum of $5 being suggested as a minimum subscription.

American Society of Mechanical Engineers.—The following papers were presented at the San Francisco meeting:

C. H. Peabody, Economy and Efficiency of the Steam Engine; B. J. Dashiell, The Electric Railroad as Applied to Steam Roads; A. F. Nagle, The Density of Water at Different Temperatures; William O. Webber, Some Tests of a Portable Boiler; William S. Aldrich, Compounding Centrifugal and Load Governing by a Rotary Piston Valve; John Richards, Notes on a Problem in Water Power; W. F. M. Goss, An Experimental Locomotive; A. W. Stahl, Utilization of Power of Ocean Waves; John H. Cooper, A Self-Lubricating Fiber Graphite for the Bearings of Machinery; Thomas Gray, Autographic Recording Apparatus for Use in Testing Materials; Thomas Gray, The Measurement of Power; Harris Tabor, Machine Molding; F. M. Rites, The Steam Distribution in a Form of Single-Acting Compound Engine; Gus. C. Henning, On the Elastic Curve and Treatment of Steel; C. H. Manning, A Novel Fly Wheel; W. R. Eckart, Friction or Lost Work of Cable Railroads; W. W. Christie, An Experiment with Aluminum; Denton and Jacobus, Summary of Results of Principal Experimental Measurements of Performance of Refrigerating Machines; Green and Rockwood, Two Cylinders *vs.* Multicylinder Engines.

THE annual meeting began in San Francisco, May 16, the opening session being held on the evening of that day. The visiting party from the East, including about 40 members accompanied by a number of ladies, arrived in the morning, and in the afternoon were escorted to several points of interest, including the great cable railroad plants of the city. The reception was in charge of the California Academy of Sciences and the Technical Society of the Pacific Coast.

At the meeting in the evening an address of welcome was made by Mr. John Richards, President of the Technical Society of the Pacific Coast, and an appropriate response was made by Mr. Robert W. Hunt, President of the American Society. The meetings and excursions were carried out according to the programme already published. A large number of papers were presented and discussed, a list of the principal ones being given above.

A number of topical subjects were also suggested and discussed.

This was the first meeting of the Society on the Pacific Coast, and although the attendance was necessarily limited by the distance and expense, it must be considered a very successful Convention, and was thoroughly enjoyed by those who were able to attend.

American Water-Works Association.—The Twelfth Annual Convention began in New York, May 18, with a large number of delegates present. The opening address was delivered by the President, J. M. Diven, of Elmira, N. Y. The reports of the officers were presented, showing the Association to be in excellent condition, and with an increasing roll of members.

The afternoon session was devoted to reading and discussion of papers. Those presented were the Brooklyn Water Works, by Samuel McElroy; Plumbing Work, by L. E. Gray; New Water Supply for Atlanta, Ga., by W. S. Richards; Restrictions on Franchises to Private Water Companies, by J. Nelson Tubbe.

In the evening a public reception was given to the delegates

by a number of city officers and prominent citizens at the Metropolitan Hotel.

On the second day two sessions were held, at which a number of papers were read and discussed. In the evening the delegates visited the theater in a body.

On the third day, Thursday, a morning session was held, at which several papers were presented and a number of questions suggested and discussed. In the afternoon a business meeting was held, at which it was decided to hold the next convention in Milwaukee, Wis., and the following officers were elected: President, G. H. Bonzenberg, Milwaukee. Vice-Presidents, James P. Donahue, Davenport, Ia.; R. C. P. Coggeshall, New Bedford, Mass.; R. M. Clayton, Atlanta, Ga.; S. E. Babcock, Little Falls, N. Y.; W. H. Watts, El Paso, Tex. Secretary and Treasurer, Peter Milne, Brooklyn, N. Y. Finance Committee, William Ryle, Paterson, N. J.; William Molis, Muscatine, Ia.; W. G. Richards, Atlanta, Ga.

Friday was devoted to visiting the Brooklyn Water Works and some other points of interest, and on Saturday the Convention closed with a steamboat excursion, members being taken to the Navy Yard and other points around the harbor.

New England Water-Works Association.—The eleventh annual convention will be held at Holyoke, Mass., beginning June 8 and lasting three days. An interesting programme has been prepared by the Committee of Arrangements, and a large attendance is expected.

American Society of Irrigation Engineers.—Mr. Arthur D. Foote, President, has issued the following circular:

"At the close of the Irrigation Congress in Salt Lake City, on September 18, 1891, a few engineers who were delegates were called together by Professor L. G. Carpenter, of Colorado, who suggested the organization of a Society of Irrigation Engineers.

"A meeting was held during the evening at the rooms of the Polytechnic Society of Utah. Little time or opportunity was afforded for details of organization. Officers were, however, elected, and the Board of Directors was instructed to draft a constitution and by-laws and send it to the members for suggestions and additions. A few hours of rather informal discussion brought out the ideas of those present as to the aims and work of such a society.

"It seemed evident to all that an organization of men interested in the physical problems of the arid regions would be of benefit to its members, and also that an organized body of skilled engineers with experience in the peculiar work of Arid Land Reclamation was almost a necessity, not for the increase of their own knowledge only, but far more for the security of those investing their time and money in reclamation or irrigation works.

"After adjournment the party dispersed, returning to their home or work in every State or Territory in the arid country, with little in the shape of a society except the hope that something useful would grow out of the meeting.

"The members of the Board of Directors reside in California, Colorado, Utah, and Idaho, and, being engineers, have many duties and little time for traveling, so that it was February before a meeting was arranged.

"In the mean time the Secretary had received many letters and much encouragement from irrigation engineers, and when the Board met it was found that 200 members were assured for the Society, including several from Europe, India, Egypt, Mexico, and South America. Success seemed no longer in doubt not only for an American society, but one that would extend all over the world.

"The Board of Directors spent several days in drawing up a Constitution and By-Laws adapted to a society, the members of which will necessarily be widely scattered. The members of the Society will be able to judge of the result of their labors as soon as the Secretary can send them the printed copies.

"The Constitution of the Society admits of

"*Members:* Those who are professional irrigation engineers.

"*Associates:* Those who, by their knowledge and experience, can co-operate with engineers in the work of irrigation.

"*Juniors:* Young men who intend to become irrigation engineers.

"There will be one annual meeting of the Society, and it is hoped that there can also be one meeting each year in San Francisco, Denver, Salt Lake, and possibly in other cities north or south. At these meetings papers will be read and discussed in the usual manner.

"It is the intention to have every one in the Society, at least once a year, give in writing something of his experience or something of his knowledge which will be of benefit. These will be published annually in book form, and this gathered experience and knowledge of irrigation engineers and of men building and managing irrigation works should be of great value and interest not only to members of the Society, but also to that vast public who are interested in the great problems of Irrigation, Forestry, and cognate subjects."

New England Railroad Club.—At the regular meeting in Boston, May 11, Colonel Frank H. Forbes gave some interesting reminiscences of the early days of railroading in New England.

The Club then took up the discussion of the Rules of Interchange. Several amendments were presented and advocated.

Central Railroad Club.—At a meeting, held in Buffalo, April 27, the Committee appointed at a previous meeting reported several amendments to the Rules of Interchange, which were discussed at some length, and approved, after some slight changes had been made.

There was also some discussion on a proposed new form of pass card to be used only for cars in local business; it is to be applied in addition to the regular defect card, when a car is in need of repairs.

New York Railroad Club.—At the regular meeting, April 21, there was no subject assigned for discussion, but the members were requested to introduce topics.

Mr. Dale spoke of a new coupler, which, it is believed, has sufficient strength to obviate the objection of breaking knuckles, which is brought against the M. C. B. coupler.

The subject of removing defect cards was brought up by Mr. West and discussed by him and by Messrs. Adams, Smith and others.

The President suggested the subject of leaking locomotive tubes, on which there was a long discussion, a number of members giving their experience, as to the effect on tubes of different kinds of coal, of dead-plates, brick arches and other devices.

Mr. Adams brought up the subject of roller bearings, and stated that on his road they had been trying the Meneely bearing and also a ball bearing, both with considerable success. The subject was further discussed by Messrs. Rogers, Brady, Blackall and others.

AT the regular meeting in New York, May 19, Mr. D. L. Barnes read a paper on Draft Rigging for Freight Cars, which was illustrated with a number of diagrams. A discussion followed.

Western Railway Club.—At the regular meeting in Chicago, April 19, the time was devoted to a general discussion of proposed amendments to the Rules of Interchange. A number were suggested and advocated by different members.

AT the regular meeting, May 17, Mr. W. H. Lewis presented a paper giving the results of experiments with Exhaust pipes and Nozzles of different sizes.

Mr. E. N. Herr read a paper on Irregular Wear of Locomotive Driving-wheel Tires, giving a number of instances drawn from experience.

Franklin Institute.—At the regular meeting in Philadelphia, April 20, the Secretary reported the death of Mr. William A. Cheyney, Auditor of the Institute, and a committee was appointed to prepare a suitable memorial of the deceased.

Mr. E. H. Outerbridge, of New York, gave a description of a new article of manufacture, called "Pantasote" leather, designed principally to serve as a substitute for leather, and especially for the more costly varieties of leather employed for upholstery, wall decorations, traveling bags, etc.

Mr. Thomas P. Conard presented a description, with lantern projections, of the Shay Geared Locomotive.

Mr. T. F. Cook, of Tacoma, Wash., followed with a description of a new method of transportation recently invented by him. The inventor employs an overhead system, the permanent way consisting of a single line of columns carrying an upper and lower girder. The invention consists further in an arrangement of horizontal pulleys, which are carried on the lower girder, adapted to be driven by any suitable motive-power and by which motion is communicated to the cars. The latter are arranged to travel in opposite directions on the two sides of the elevated structure.

THE Committee on Science and the Arts, at its stated meeting of May 2, adopted reports on the following subjects: Millikin's improved post for electric service; Gibbon's street railroad rail; Golding's & Durkee's expanded metal; Lungren's

incandescent gas-burner; McClellan's anti-siphon trap-vent; the Woodbury engine, and Roeder's & Greene's improved windows. In the cases of Gibbon, Golding & Durkee, Lungren and McClellan, the Committee recommended the award of the John Scott Legacy Premium and Medal, and in the case of Roeder, the applicant was awarded the Edward Longstreth medal.

Engineers' Club of Philadelphia.—The regular meeting of April 2 was devoted to an informal discussion of the trolley system for operating street cars by electricity. A large number of members took part in the discussion, and the arguments for and against this system were strongly stated. The discussion was not concluded, but was continued to the meeting of May 7.

Engineers' Society of Western Pennsylvania.—At the meeting of the Chemical Section, March 24, Mr. James O. Handy read a paper on a rapid method for Phosphorus Determination in Iron, Steel and Ores.

AT the regular monthly meeting of the Society, April 19, Professor J. W. Langley, for the Committee on Smoke, reported that the Committee had met and assigned each detail to be considered to different members of the Committee.

The paper of the evening was read by Mr. G. S. Davison, on Discharge Observations of Large Streams. The paper reviewed in brief the work accomplished by separate investigations, beginning in the seventeenth century and closing to date. It was especially interesting in the details furnished from the author's personal work, when engaged as an Assistant Engineer under the Mississippi River Commission during 1879 and 1880, when he was detailed for duty at Fulton, Tenn., about two miles below the historic Fort Pillow. A full description of the character and management of the floats, both single and double, was given in detail, as well as the method of obtaining mid-depth velocity. The irregularity of all results obtained from different known formulas was shown. The paper concluded with the following *résumé:*

"As to the particular system to be used, we believe the double-float system, carefully conducted, will give good results up to a velocity of 10 ft. per second. Current meters, carefully rated for coefficients and used with chronograph, will give very accurate results. They are stationary at a point in the section while in use. The former depends on the average of its approach to and departure from the discharge section for its main velocity through the same, while the latter gives the condition of things immediately at the section. The meter cannot be used for high velocities, as in swift currents it would be difficult to hold in place the craft from which the observation must be taken. In the experiments at Burlington, Ia., comparisons of these systems were made, showing very slight differences, so slight as to practically give the same results. The current meters recorded the actual pulsations of the water, thus representing very slight change in the velocity. All the oscillations within the path of a moving float are averaged."

The paper was illustrated by cuts showing cross-sections of the river, the floats, and the lines of observations.

Engineers' Club of Cincinnati.—At the April meeting of the Club there was an attendance of 45 members and several visitors. One new member was elected and three applications for membership presented. There has been a very active interest in the affairs and administration of the Club during several months past.

Mr. Bouscaren read a very interesting paper on the subject of the work being done to restore the anchorage of the cables of the suspension bridge between Cincinnati and Covington. The bridge was erected in 1866, and a recent examination of the anchorages revealed the necessity of strengthening the cables at these points, and Mr. Bouscaren has had charge of the work.

AT the last regular meeting of the Club 13 new members were elected, making the membership 123 at that date.

Colonel Latham Anderson read a paper on a proposed New Type of Dam. He was a member of a commission of Engineers appointed by the Arrowhead Reservoir Company, to prepare plans for a system of irrigation for supplying the territory north and west of San Bernardino, Cal. The water for this purpose is to be obtained from the headwaters of the Majore River. In a particular basin in the mountains at this place, described by the writer, there are four consecutive branches of the Majore having admirable sites for dams and reservoirs, all of which will be used, but the largest and the one which will be used first is known as the Little Bear Valley.

Engineers' Club of St. Louis.—At the regular meeting, April 20, Captain C. F. Palfrey was elected a member.

Mr. B. F. Crow then read the paper of the evening on Elements Involved in Rapid Transit. The subject was divided into two parts: First, the development of a new system, and second, the study of methods to increase the efficiency of lines already in existence. The second method is the one in which the greater number are interested. One of the greatest drawbacks to rapid transit has been the poor roadbeds and poorly designed curves which answered the purpose for the horse cars, but were inadequate for the present system. The terminal facilities was another point which made trouble when it was attempted to run a number of trains with a small headway. The question of stops was one which presented serious difficulty to obtaining any high rate of speed. The paper also dwelt on the question of car construction, and showed some of the advantages obtained by newer and better designs.

Discussion followed by Messrs. Hermann, Crow, Seddon, Moore, Johnson, Crosby, Olshausen, Maxon, Colby, Russel and Woods.

Civil Engineers' Club of Cleveland.—The regular meeting of the Club was held May 16, in the Club rooms. Five active and one associate member were elected. Dr. Staley, President of Case School of Applied Science, was elected delegate to the Fifth International Congress on Inland Navigation.

Mr. C. W. Hopkinson read an interesting paper on Whither is our Architecture Tending?

Mr. Searles, a member of the Club and one of the engineers of the North River Bridge at New York, gave a very interesting account of the proposed structure.

Denver Society of Civil Engineers.—At the regular meeting April 27, Mr. Thomas Withers read a paper on the Ventilation of Tunnels, describing the various methods which have been tried.

Mr. F. H. Whiting read a paper on Electric and Cable Railroads in Denver. Both papers were briefly discussed by members present.

Technical Society of the Pacific Coast.—At the April meeting in San Francisco, Andrew Fraser, Edward C. Jones, Leon H. Taylor and Professor Charles David Marx were elected members.

Mr. D. E. Hughes presented a paper on the Sickle, or Perfect Railroad Curve.

The following question was submitted for discussion: "What is the effect of Modern Brakes upon the Railroad and its Supporting Structures?" The discussion was carried on by Messrs. Von Geldern, Hughes, Curtis and others.

Professor Willard D. Johnson made an address on the proposed Topographical Survey of the State, and a special committee was appointed to aid in advocating such a survey.

NOTES AND NEWS.

A Remarkable Hydraulic Plant.—The Pelton Water-Wheel Company, of San Francisco, is constructing a water-wheel 36 in. in diameter, to operate under a head of 2,100 ft., or a pressure of more than 900 lbs. per square inch. The wheel is to run at 1,150 revolutions per minute, and have a speed at its periphery of 10,805 ft. per minute, which is at least one-third faster than circular saws are driven. The wheel is to be placed in one of the Comstock mines and, in addition to the depth of the mine, is to be fed from the Virginia water-mains, which have a pressure of 198 lbs. to begin with. The diameter of the jet will be only 0.15 in. The wheel will be of solid steel, a tempered plate $\frac{1}{2}$ in. thick.

It is a remarkable case, and will be watched with much interest. Various kinds of phenomena will, no doubt, be observed in respect to erosion of the surfaces, especially of the nozzles. This will be by far the greatest head or pressure ever applied to a water-wheel.—*Industry, San Francisco.*

Protection for Steel Ships.—The *Revue Scientifique* notes that at a recent meeting of the Institution of Naval Architects, in England, Mr. F. C. Goodall, Engineer for the Corporation of the Trinity House—which is the Board in charge of lighthouses—strongly recommends the use of steatite for coating the plates of steel ships. Steatite, more commonly known as soapstone, is a soft magnesian rock which is found in the Alps, in England, in Germany, in the United States and in China in large quantities. It has some valuable qualities. It is not affected by extreme temperatures nor atmospheric influences; it is incombustible; it is a very bad conductor of heat; it is not a conductor of electricity at all; it is not attacked by acids;

finally, it can be ground very fine and will adhere closely to a smooth surface.

It is stated that the Chinese, anticipating European invention here as in some other cases, have for many centuries used this mineral as the base of a paint used for covering stone buildings and for painting their junks.

Mr. Goodall states that when mixed with oil or with an ordinary dryer, steatite will not dry completely; but, aided by the advice of the Holzapfel firm, he has obtained excellent results by dissolving it in a varnish. The varnish makes a pigment sufficiently elastic to prevent cracking, while the pores are entirely filled by the very fine particles of the steatite, and a coating is formed which, it has been shown by experiment, will protect iron and steel plates from the air, water and galvanic action, through a period of several years. It is, moreover, not an expensive material, and can be readily obtained in large quantities and ground up to the required fineness without difficulty.

In this connection it is well also to recall the experiments in the use of lacquer for ship's plates, which is advocated by Mr. Hotta, and to which reference has heretofore been made in our columns. Some interesting experiments are now in progress in this direction with lacquer as a protection for iron and steel against the corroding influences of air and sea water.

A Gas-Fired Boiler.—The accompanying cut shows a form of gas-fired boiler lately patented in England by G. H. Taylor and W. O. A. Lowe. It is an improvement of that form in which the gases are led from the producer to the combustion-chamber by means of downtakes. In the new form these may

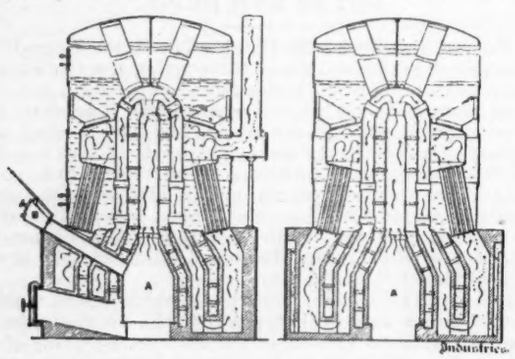
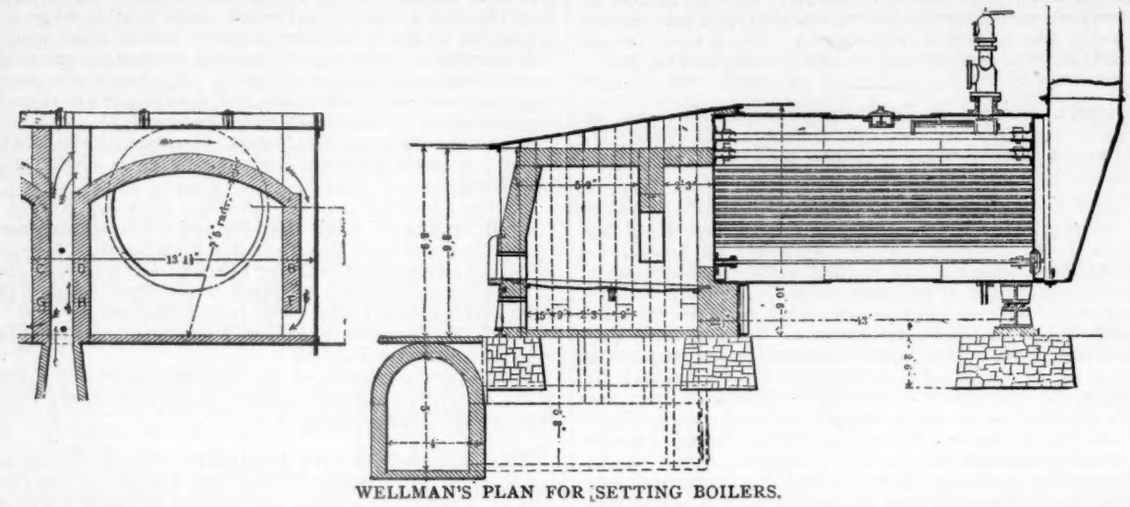


FIG. 1. FIG. 2.

A] GAS-FIRED FURNACE.

be dispensed with, and the producer, along with the uptake, is surrounded by an enveloping hollow chamber, into the upper end of which the gases generated in the producer are led, and down which again they are conducted into the combustion-chamber, where ignition takes place. A water-space is left between this enveloping chamber and the producer and uptake, and this space is, by means of suitable passages or openings, placed in free communication with the surrounding water contained in the boiler, so as to ensure perfect circulation, as well as to permit of the escape of steam into the surrounding water in the boiler. The accompanying illustrations, figs. 1 and 2, represent vertical sections at right angles to each other of a boiler so constructed; the arrows shown in full lines representing the course of the gases, while those shown dotted represent the course of the air. *A* represents the producer furnace, and *B* the hopper through which fuel is supplied.

A Good Boiler Setting.—For some time past the Wellman Iron & Steel Company, of Thurlow, Pa., have had running in their No. 2 boiler house a battery of boilers designed by S. T. Wellman, which embody novel features, and, using a cheap coal, have proven very economical. As will be noted from the accompanying engravings, the notable point in the design of the boiler is the fact that it has a detached fire-box, and that the products of combustion pass simply through the flues to the stack. The direct tubular boilers are each 90 in. diameter of shell and 15 ft. long, and contain 266 flues 2½ in. in diameter. The area of heating surface is 2,300 sq. ft., while the grate surface is 64 sq. ft., the area through the tubes being 7¼ sq. ft. The ratio of the heating to grate surface is, therefore, 36 to 1, while the ratio of grate surface to tube area is 8½ to 1. The boilers use forced draft at 1 oz. pressure, supplied by a Sturtevant blower. As will be seen from the drawings, the air is forced through underground flues up through the side walls of the furnaces over the roof and front, being thus slightly heated. It then passes to the ash-pit and under the grates. One result of this method is that the front is kept quite cool. In February a number of tests were made on No. 4 boiler with average results as follows: Coal burned per hour per square foot grate, 12.9 lbs.; water evaporated per hour, per square foot heating surface, 2.9 lbs.; water evaporated per pound of coal, 8.03 lbs. The average boiler pressure was 93 lbs.; temperature of feed-water, 124.5°; temperature of escaping gases, 410°. The three tests, from which these averages are taken, lasted in all 254¾ hours; during that time fires were cleaned 54 times.



WELLMAN'S PLAN FOR SETTING BOILERS.

With ordinary rice anthracite coal as a fuel these results are certainly very flattering. The boiler is simple, quickly and easily set, and the cost per horse-power is very low.

A simple method has been adopted for cleaning it. A steam jet has been arranged for each stack. Once a day steam is blown into the stack, which carries off all the dust which may have settled in the flues.—*Iron Age.*

Open Suburban Cars.—The Illinois Central car shops at Chicago are building several hundred open cars for the use of visitors to the Exposition. The car is designed to seat 110 persons comfortably, although at least 24 more average sized persons may be accommodated with seats. The length of the vehicle over all is 53 ft. and from sill to sill, 45 ft. 1 in. The width is 8 ft. inside and the height from rail to roof, 13 ft. 9¼ in. Across the ends of the car are seats, and there are, in the interior, 10 double-seated compartments. No steps or platform will be attached to the car, as the train will make no stops between Van Buren Street and the Exposition grounds, and the platforms at the terminals will be of the same height as the floor of the cars. In finish the coaches will be of the same style as the suburban cars.—*National Car-Builder.*

An Electric Locomotive.—Foreign papers state that a firm in Basle, Switzerland, is building an electric locomotive of 1,500 H.P. It will be carried on six wheels and will have three motors, one attached to each axle. It is expected to attain a very high speed.